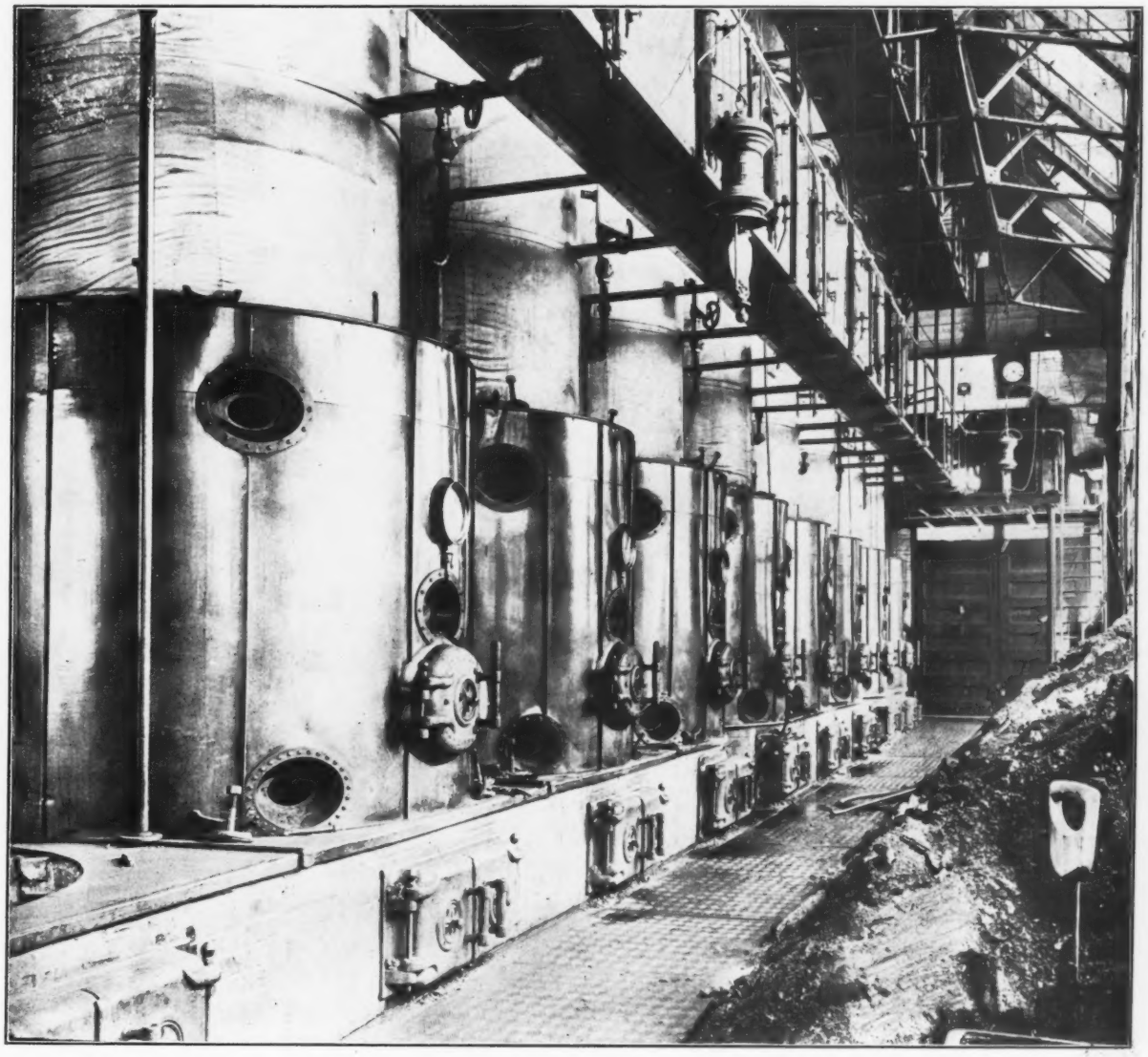
FIFTY CENTS A YEAR FIVE CENTS A COPY

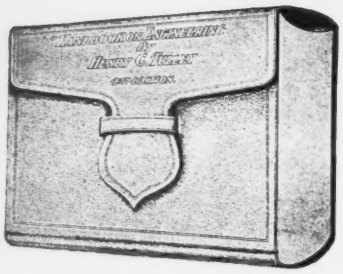
THE PRACTICAL ENGINEER

VOL. VIII. Philadelphia, December, 1904 No. 11

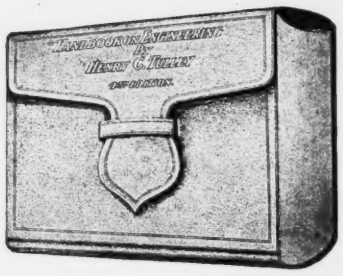


Boiler Room of the Yale and Towne Mfg. Co., Stamford, Conn.

Published Monthly at 46 N. 12th St., Philadelphia For Engineers and Engineers only



WANTED
Chief Engineer
Salary $1800 Per Year



What sort of men, do you suppose, land jobs like that? The answer is easy. They go to men who know their business. And how do they learn it? Partly by experience and partly by studying during their off hours instead of fooling away their time. Lots of your friends owe their success to

Tulley's Handbook on Engineering

It's a complete library on steam and electrical engineering, refrigeration, elevator work, etc.—written by an engineer who knows for engineers who want to know. There are 990 pages of solid "meat"—no "froth" no "gas"—just good, straight, salary-raising information. It's yours for $3.50 and you can have your money back if you don't like the book. Send for 62-page booklet A.

A Business Proposition!

When You Spend Your Good, Hard-Earned Money For Books, Always Make Sure That You Are Going to Receive Something That Will Assist You to Bettering Your Position.

Good books that teach, no matter what they cost, will earn you more money than any thing else you can buy.
Tulley's Handbook is the only Handbook on the market that is sold with the distinct understanding that if it is not satisfactory it may be returned and your money will be refunded.

It's All Right,

My boy, to get a College Education if you can, but for those of us who can't, there isn't any substitute as good as TULLEY'S HANDBOOK ON ENGINEERING.

You'll find everything you want to know about your job, and the jobs higher up, in this book and it's all in such a shape that you can understand and use it. You might spend ten times the money and get a lot of books that would be full of Algebra and Greek letters and that sort of business, but Tulley being an engineer himself knows just the way engineers look at things.
Over fifteen thousand of Tulley's Handbooks have been sold in the last three years and but two have been returned.

The 4th edition of Tulley's Handbook is a wonder on Electrical and Mechanical Engineering.

Henry C. Tulley & Company

Room 402 Wainwright Building **ST. LOUIS. MO.. U. S. A.**

GOLD MEDAL

AWARDED DEARBORN METHODS OF TREATING BOILER WATERS and DEARBORN VEGETABLE FEED-WATER TREATMENT at the WORLD'S FAIR, ST. LOUIS.

This award was made from results obtained in keeping a battery of 3000 horse-power water-tube boilers absolutely free from scale and corrosion during the six months run of the World's Fair Power Plant.

Are *you* using DEARBORN VEGETABLE FEED-WATER TREATMENT in your boilers? If not, send gallon sample of water for analysis.

Write for Booklet "N"

DEARBORN DRUG AND CHEMICAL WORKS

WM. H. EDGAR, President
CHAS. M. EDDY, Sec. and Treas.

ROBT. F. CARR, Vice-Pres. and Gen. Mgr.
WM. B. McVICKER, 2d Vice-Pres. and East Mgr.

LABORATORIES AND WORKS, CHICAGO

NEW YORK:
120 Liberty Street

Philadelphia Office: The Bourse

CHICAGO:
27-34 Rialto Building

BRANCH OFFICES

Boston, Oliver Building
Pittsburg, House Building
Buffalo, Ellicott Square Building
Cincinnati, Union Trust Building
Detroit, Majestic Building

Atlanta, Prudential Building
St. Louis, Security Building
Kansas City, New York Life Building
St. Paul, 1237 Lincoln Avenue

Denver, Boston Block
Salt Lake City, Dooly Block
San Francisco, 115 Davis Street
Los Angeles, 307 N. Los Angeles Street
Honolulu, Brewer Block

RAINBOW PACKING

Do Not
Be Deceived

"Just as Good" Packings
Are Good for Nothing

RAINBOW PACKING HAS NO RIVAL

Ask for RAINBOW and be sure you get it.

Look for the Diamonds with the word RAINBOW within.

THE ENGINEER'S FRIEND

Can't blow Rainbow out.

Will hold the highest pressure.

Durable
Effective
Economical
Reliable

You Are Sure of TIGHT JOINTS, if You Use RAINBOW PACKING.

Don't be Bamboozled into Using Cheap Imitations

MANUFACTURED, PATENTED AND COPYRIGHTED EXCLUSIVELY BY

The Peerless Rubber Manufacturing Company

16 WARREN STREET, NEW YORK

16-24 Woodward Ave., Detroit, Mich.
Cor. Common and Tchoupitoulas Streets, New Orleans, La.
210-214 N. Third St., St. Louis, Mo.
1218 Farnum St., Omaha, Neb.
202-210 S. Water St., Chicago, Ill.
634 Smithfield St., Pittsburg, Pa.
1601 to 1615 17th St. Denver Col.

220 South Fifth St., Philadelphia, Pa.
17-23 Beale, St. and 18-24 Main St., San Francisco, Cal.
1221-1223 Union Avenue, Kansas City, Mo.
709-711 Austin Ave., Waco, Texas.
51-55 N. College St., Charlotte, N. C.
Cor. Ninth and Cary Sts., Richmond, Va.
20th St. and Railroad Ave. Birmingham, Ala.

The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

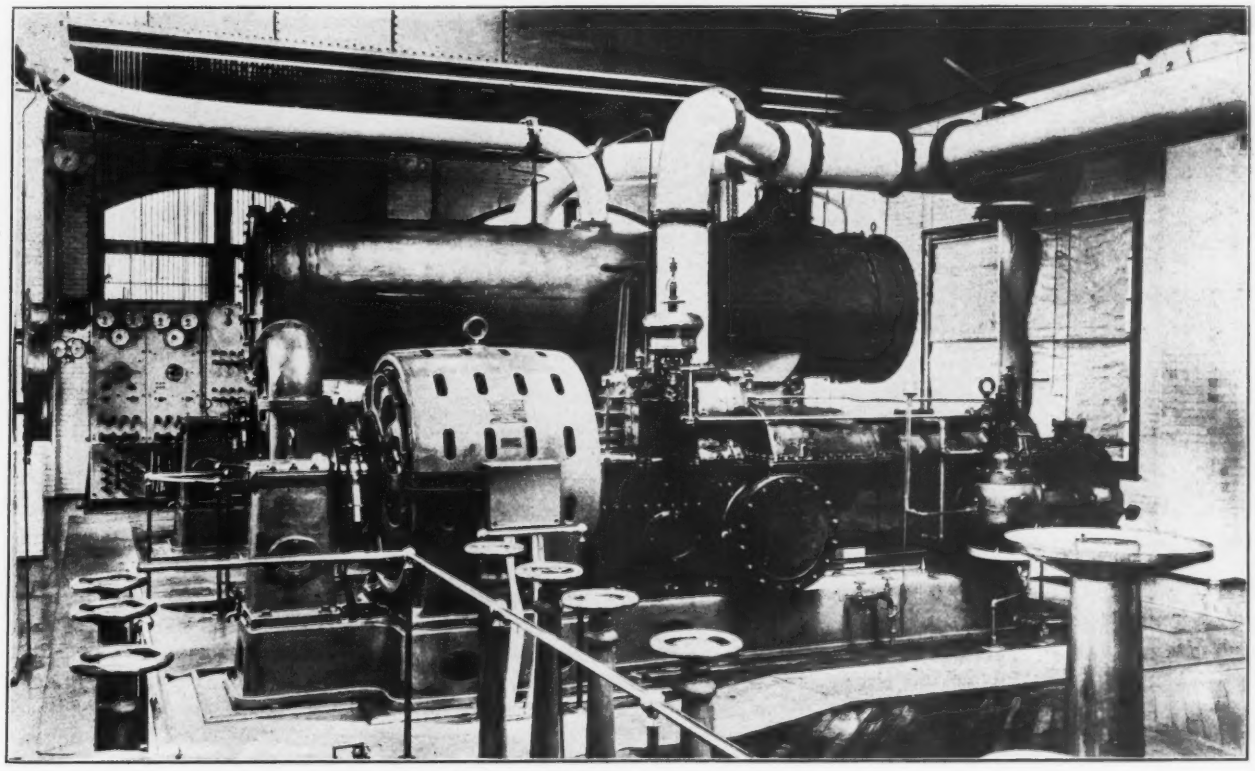
VOL. VIII PHILADELPHIA, DECEMBER, 1904. No. 11.

A NEW ENGLAND POWER PLANT

A Manufacturing Establishment Which Uses Steam Turbines for Power.

BY FRANK C. PERKINS.

The steam turbine power plant, of the Yale & Towne M'f'g Co., has recently been completed at Stamford, Conn., and now includes two turbo-alternators of 400 kilowatts each. The first steam turbine installed at this power house was one of the earliest installations of this class of prime mover in the United States. With the placing of the new steam turbine at this plant, as shown in the accompanying illustration, there have been a number of important changes, the ordinary form of surface condenser being replaced by the dry vacuum system of condensing the exhaust steam, the same pump removing the steam, water and air. The liability of a shut-down, when the turbines are running at full load on account of the failure of the vacuum, has been obviated by placing an automatic by-pass on the turbines.



Steam Turbine Plant at Stamford, Conn.

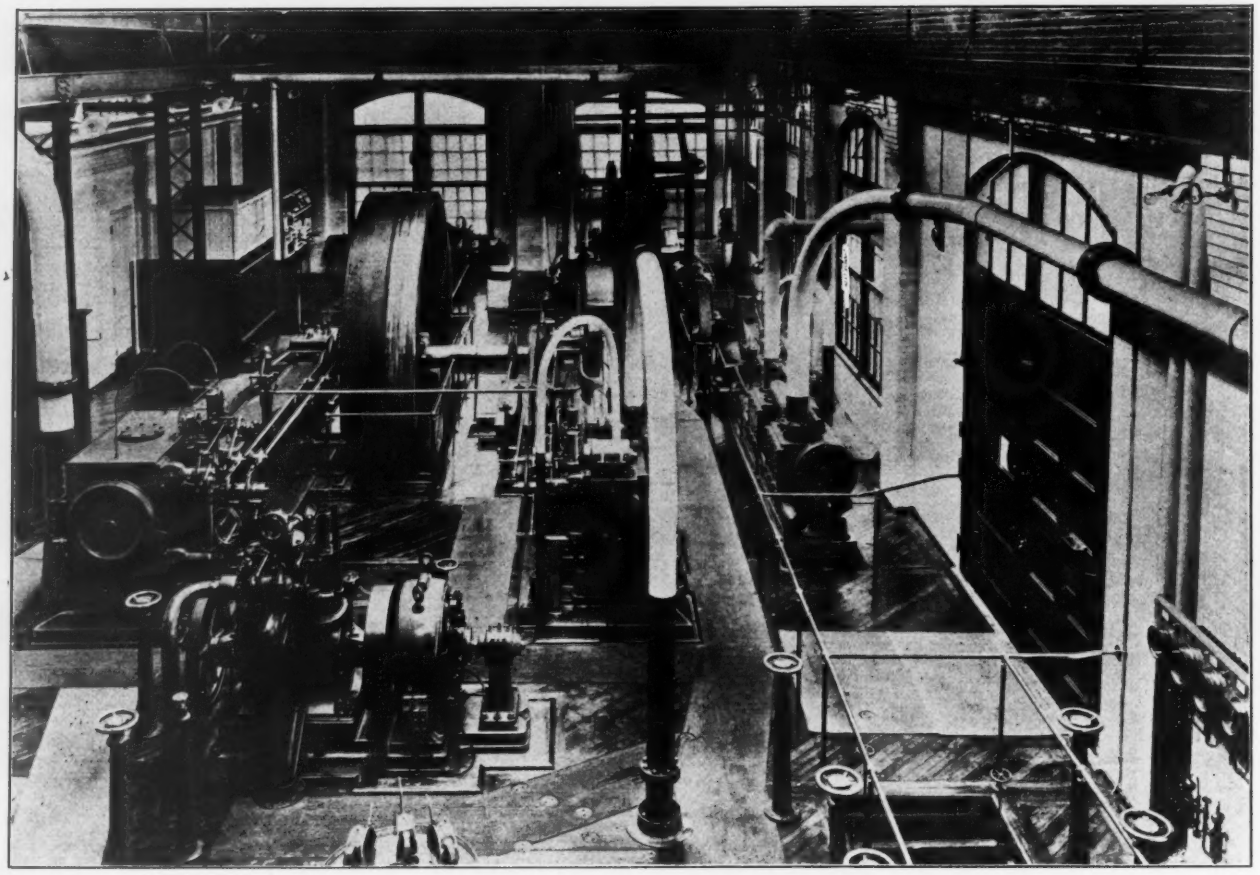
Each of the two Parsons Steam Turbines drive by direct connection a 400 kilowatt two-phase alternator supplying a

current of 240 volts pressure. This capacity is obtained when the power factor of the alternator is more than 90 per cent. and the turbine is running condensing at a speed of 3,600 revolutions per minute. The two-phase alternators supply a current of 7200 alternations per minute, the revolving fields of the machines having a peripheral speed of over 22,000 feet per minute. Each turbo-alternator is 4½ feet wide and 19 feet long, weighing nearly 17 tons. The generators are not provided with a compound winding but the regulation is said to be very satisfactory. The fields of the alternators are excited from a direct current generator of 17½ kilowatts supplying a continuous current at a pressure of 140 volts. This dynamo is driven at a speed of 430 revolutions per minute by a vertical steam engine of the Westinghouse type.

The turbo-alternators are supplied with a force lubricating system in which the oil is pumped to the bearings and steam chamber from a reservoir in the base of the unit, where it is cooled before again being pumped through the circulating system. The steam consumption of these units was found to be 15 lbs. per electrical h. p. per hour, the superheat being 20 degrees F., the gauge pressure 150 lbs. per square inch and the average vacuum about 28 inches.

The engine room has an area of about 3350 square feet, and the two steam turbines are supplied with steam from the boiler room from an 8″ main under the engine room floor, two 5″ pipes connecting the main with the turbine. The boiler room has an area of nearly 2500 square feet and is equipped with 8-135 h. p. vertical boilers of the Manning type. These boilers operate at a maximum steam pressure of 165 lbs., each having a heating surface of 1388 square feet, a grate area of 27¼ square feet and a superheating surface of 467 square feet. The boilers are provided with rocking grates of the Century type and a Green economizer of 1728 square feet heating surface, including 144 tubes, each 4″ in diameter. A fan 4½ feet wide and 9 feet in diameter is used to provide the induced draught. It is driven by a direct-connected horizontal 8 x 10 engine at a speed of 115 revolutions per minute and is controlled by a Locke regulator. The construction is so arranged that the fan or the economizers may be by-passed. The fan discharges into the base of the smoke stacks located at one end of the building.

In addition to the steam turbines in the power plant, there is also in operation a cross compound Harris-Corliss steam engine having a capacity of 300 h. p. This engine has high pressure and low pressure cylinders 12″ and 22″ in diameter respectively, with a stroke of 3½ feet. The engine drives an alternator of the Westinghouse type of 120 kilowatts capacity by belt transmission from a 16 foot fly-wheel. This engine is utilized only during the early hours in the morning and late in the afternoon, as the alternator it drives only supplies current for lighting purposes, while the steam turbo-alternators are used exclusively for power transmission, although they supply the necessary lighting current when the Corliss engine is not in operation.



Engine Room of the Yale and Towne Mfg. Co., Stamford, Conn.

The steam turbines are allowed to exhaust into the heating system of the building during the winter, for a portion of the time each day, and into an Alberger surface condenser during the remainder of the time. This condenser noted in the accompanying illustration is 4 feet in diameter and 18 feet in length and has a cooling surface of 4000 square feet. While the exhaust steam is being used for heating the various buildings, a suction pump is employed to insure the circulation of the steam.

A tandem Corliss engine is utilized for driving an Alberger vacuum pump having two 18" air cylinders. This two-stage air pump will maintain a vacuum as high as 29 inches with both steam turbo-alternators in operation, although under ordinary circumstances only one of the turbine units is required to be in operation at any one time, the capacity of each unit being sufficient to carry the entire load. In the pit below the condenser, an Alberger pump has been installed for draining the water of condensation from the condenser, this water being pumped to a hot well in the boiler room and is then forced into the boilers by the feed pumps. The first turbine installed is said to have operated from nine to ten hours a day continuously for more than a year without being stopped at any time. The power consumption of the plant includes nearly 70 motors of various sizes ranging up to 40 horse power capacity. The entire plant is operated by alternating current machines of the induction type with the exception of the motor cars on the trolley system.

Engineering Projects on the Canadian Side of the Niagara.

Three different power houses, with all their accompanying flumes, penstocks, turbines and generators, are being built on the Canadian side of Niagara Falls. Of the three, the Canadian Niagara Power Company are furthest advanced. This company has completed its tunnel and its power station is quite well along, and it will be the first to have its power output ready for the market on the Canadian side of the river, and the City of Toronto, 90 miles away, will be among the first to receive current from this plant. The company building this plant is practically the same as the one which built the famous power house on the New York side of the falls. The Canadian plant will exceed the plant on the New York side both in total output and the individual size of the units. The Canadian plant will have 10,000 horse power units, while its neighbor across the river has 5000 horse power units, which, however, a few years ago was considered to be a remarkable size.

The Electrical Development Company of Ontario, Ltd., is another company that is hard at work sinking a wheel-pit and driving a tunnel on the Canadian side for the development of 125,000 horse power. The site selected by this company is up the river from the plant of the Canadian Niagara Power Company. Its method of development is identical with that of the Canadian Niagara Power Company, that is by means of a wheel-pit and tunnel. Both the tunnel and wheel-pit are now being excavated. The tunnel will be about 2200 feet long and slightly larger in section to the tunnel built by the Canadian Niagara Power Company. In the wheel-pit there will be 11 turbines, and these will be connected by vertical shafts to generators of 8000 kilowatts located in the power house over the pit. The tunnel of this company will discharge behind the Horseshoe Fall, and after it leaves the wheel-pit the velocity of the water through the tunnel will be a little faster than 25 feet per second.

The Ontario Power Company is the name of the third company that is developing power at Canadian Niagara. So far as Niagara is concerned, the plan of this company is quite original in that water will be taken from the upper river through two big forebays, and after it has passed through ice screens and a gate house it will flow into three steel flumes or tubes, each of which is 18 feet in diameter. Each pipe will be over a mile long, and laid in a trench especially excavated for it, after which it will be covered up with earth so that its presence will not mar the beauty of Victoria Park, through which the big steel flumes will run.

When these flumes reach a point near old Table Rock the water they carry will be discharged in a forebay and from this forebay it will pass into penstocks that will carry it to turbines to be installed in a power station to be located at the water's edge in the gorge, only a very short distance below the Horseshoe Fall. This power house, when all its sections are completed, will be over 1000 feet long, and it will be the nearest building to the Horseshoe Fall ever erected.

On the bluff, back of Victoria Park, at the top of the high bank, the Ontario Power Company will erect its transformer station, and the current generated in the power house at the water's edge will be carried on cables up the bank to this station, from which point it will be distributed. While the Canadian Niagara Power Company and the Electrical Development Company of Ontario, Ltd., will use vertical turbines and shafting, the Ontario Power Company will use horizontal wheels, the principle of development being somewhat similar to that employed in the power house of the Niagara Falls Hydraulic Power and Manufacturing Company, on the New York side at Niagara. This latter company has a power station located at the water's edge in the gorge on the New York side. The water used is carried through a surface canal 4400 feet long to the high bank of the lower river, where it empties into a basin, and from this basin it passes to forebays and then into penstocks that stand out in column form from the cliff. These penstocks carry it to the turbines in the station. On the Canadian side, the Ontario Power Company's penstocks will be concealed in tunnels driven through the cliff to accommodate them, and thus the scenic feature close by the fall is not expected to be materially marred by their presence.

Only one of the great steel flumes is being built at present. Each flume will discharge about 4000 cubic feet of water every second, so that the total water carrying capacity of the three great flumes will be about 12,000 cubic feet of water per second when the completed plant is in full operation. All this water will be diverted from the Horseshoe Fall, as well as all the water to be used by the Canadian Niagara Power Company and the Electrical Development Company of Ontario, Ltd. The water from each of the big steel flumes of the Ontario Power Company is expected to develop over 50,000 horse power, so that the total amount of power projected by this company for development is over 150,000 horse power.

The combined development projected by the three companies mentioned as at work on the Canadian side at Niagara is about 375,000 horse power. This is an immense amount of energy, and it will be long years before it is all applied to the operation of industrial features, no matter how far it may be transmitted.

THE PRINCIPLES OF MECHANICAL REFRIGERATION

The Absorption and Compression Systems of Ammonia Refrigeration.

There are two systems of mechanical refrigeration which have survived the experimental stage and which are now the only ones in practical use to-day. They are the absorption system and the compression system. With the absorption system, the use of ammonia is universal but with the compression system, ammonia, sulphur dioxide, carbonic acid gas or compressed air can be used. By far the most compression systems use ammonia for the refrigerating medium because it has certain peculiar physical features which make it valuable and it involves the least expense in machinery and cost of running. Sulphur dioxide has certain properties which make it valuable as a refrigerating medium but the cost of the gas itself has prohibited its extensive use. Carbonic gas is used on shipboard to some extent, as the size of the apparatus for a given output can be made small, but the principal objection to its use is the high pressures which it is necessary to carry. The principal objection to compressed aid is the considerable size and space of the apparatus which is necessary for a given output. Generally, then, when refrigeration is spoken of, ammonia is assumed to be the refrigerating medium.

As ammonia is employed in both the absorption and compression systems, a few facts about it will prove interesting. Ammonia gas consists of the chemical combination of one part nitrogen and three parts hydrogen, and as such it is free from water and is known as anhydrous ammonia. When mixed with water it does not combine with it but the water absorbs it, which combination is known as aqua ammonia. At atmospheric pressure, a given volume of water will absorb about 800 times its own volume of ammonia and will give it off freely when warmed. Just as water boils under different temperatures when subjected to different pressures, so does ammonia have a corresponding temperature of boiling and of liquefaction, at which temperature ammonia gas will liquefy if heat be abstracted from it, and ammonia liquid will become a gas if heat be added to it. The accompanying table shows the various temperatures and gauge pressure from — 40 to + 160 degrees at which ammonia changes from a liquid into a gas.

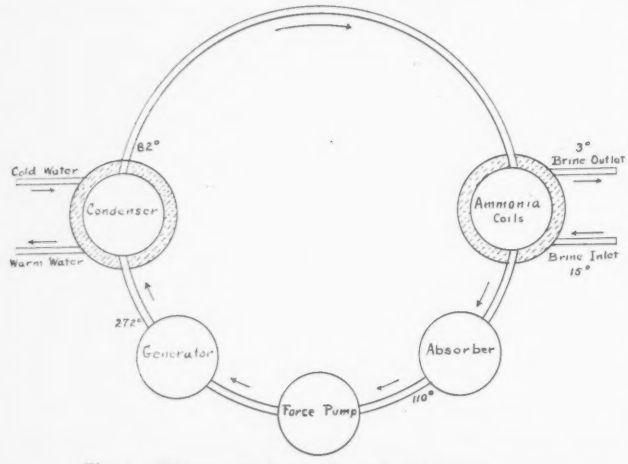


Fig. 1. Diagram of Ammonia Absorption System.

Critical Temperature in Degrees Fahrenheit.	Gauge Pressure in Pounds per Square Inch.
— 40	— 4.01
— 30	— 0.57
— 20	3.75
— 10	9.10
0	15.6
10	23.6
20	33.2
30	44.7
40	58.3
50	74.2
60	92.9
70	114.5
80	139.4
90	168.0
100	200.4
110	237.3
120	275.8
130	325.7
140	377.5
150	435.5
160	499.7

Whether the absorption or compression system is used, the artificial abstraction of heat is the object of both and in principle it is exactly the reverse of the process upon which the steam engine works, for instead of transferring heat into work, work is transmitted into heat. Their operation is essentially the same in principle: condense the gas or vapor, deprive it of heat diminishing its volume, lower its temperature by doing work, and then expand it; during the last operation the heat is supplied by the articles to be cooled, which produces the refrigerating effect. The heat of the refrigerating room is carried out by the circulating water of the condenser. During the passage of the ammonia to the condenser, the generator or compressor raises its temperature and pressure and by removing the heat at the condenser, the circulating ammonia is ready to take up the heat again as it passes through the refrigerating coils.

The absorption system depends upon the principle of absorption and expulsion of ammonia gas in water. This system involves the continual evaporation of the ammonia gas and comprises a generator which contains a concentrated solution of ammonia in water. This generator is heated either directly by a fire or by pipes leading from a steam boiler. The condenser is connected to the generator and is cooled externally by a current of cold water. The ammonia coils are connected to the condenser and are supplied from it with liquid ammonia under a constant pressure which pressure is reduced as the ammonia passes into the cooler. The liquid and a small amount of vapor are now surrounded by the brine from which it absorbs heat, consequently reducing the temperature of the brine. During the process of cooling the brine, the liquid ammonia becomes a gas and passes to the absorber, which is filled with a water solution of ammonia. The water absorbs the gas and

strong aqua ammonia is formed, which is pumped back to the generator, the ammonia again driven off and the operation is repeated. Fig. 1 shows a diagram of this system.

In practice, the upper part of the absorber is connected to the lower part of the generator and the lower part of the absorber with the upper part of the boiler on which pipe line the pump is attached. This is done to get a constant circulation of the water so that it can be used over and over again. The upper part of the generator contains the more highly saturated ammonia solution while the bottom is nearly pure water, so that this is allowed to run back into the absorber as the strong ammonia solution is pumped out into the top part of the boiler.

The amount of cooling that is done is regulated by the flow of the liquid, which varies the pressure and, consequently, the temperature of the cooler can be controlled. The process is similar to a compression system, the mechanical force for producing exhaustion being supplied by the absorption power of the water and the mechanical force required for compression is replaced by the heat of the generator which sets the gas free

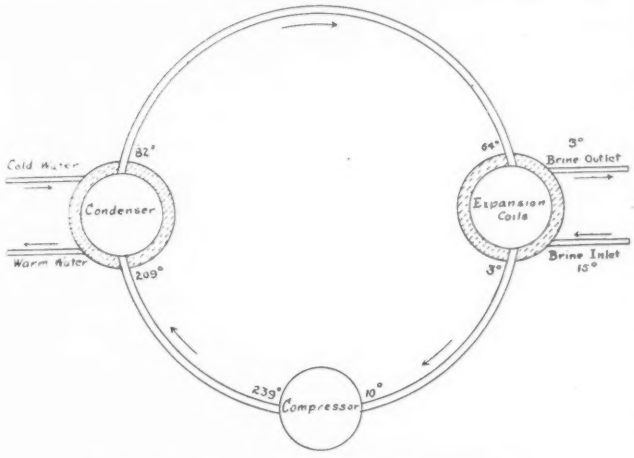


Fig. 2. Diagram of Ammonia Compression System.

from the water. The only mechanically-operated feature of this system is the force pump used to pump the aqua ammonia from the absorber into the generator.

With the compression system, the use of a mechanically-driven compressor is the base of the system and differs from the absorption system inasmuch as in that system the steps are chiefly chemical, in the compression system they may be said to be mechanical, although the ammonia passes through exactly the same cycle, the steps of which are compression, condensation and expansion. Fig. 2 shows a skeleton diagram of the compression system. In this system, the compressor compresses the ammonia to a pressure of about 150 pounds and as it leaves the compressor it is in a gaseous state on account of the heat it contains. It then passes through the condenser, where it gives up its heat to the surrounding water and in consequence the temperature is reduced below its critical temperature at that pressure and the ammonia becomes a liquid. It is then forced into the expansion coils where the refrigeration is produced. The liquid ammonia at a high pressure is allowed to expand in the coils at a low pressure with the result that the liquid becomes a gas. In changing from a liquid to a gas, it must absorb heat from the surrounding objects in order to have given to it its latent heat of evaporation. The result is a temperature considerably below the temperature of the freezing point of water and hence the required refrigeration is accomplished.

An advantage of the absorption system is that the bulk of the heat required for performing the work is applied direct without being transferred into mechanical power, but in actual tests the efficiency of each system is about the same when the compressor uses 3 pounds of coal per hour per indicated horse power and if the compressor runs at a greater economy than this, then the compression system may be said to be more economical, but if it requires more coal per horse power per hour then it would probably be less economical.

There are two systems of refrigeration in use: the direct and the indirect. In the direct system, the expansion coils are placed directly in the room or in direct contact with the medium to be cooled. It has the advantage of economy in operation, as no auxiliary devices are necessary, but it has the disadvantage in that the machinery must remain in constant operation in order to maintain constant refrigeration. This is overcome by the use of duplicate apparatus. Another objection to the direct system is due to the danger of leakage of ammonia in the refrigerating chamber through fittings, joints, etc., and many articles of merchandise would be rendered valueless if this happened, but where a leak or the odor would not be objectionable, the direct system can be used to the best advantage.

There are two systems of indirect refrigeration. The most important is the use of brine, which is a saturated solution of either sodium, calcium or magnesium chloride, which remain liquid at a low temperature. It is by far the most useful means for applying the cold to various uses, its principal objection being the increased expense and loss of economy due to the operation of the system of brine pumps and refrigerating tank.

Air is another medium used for indirect refrigeration. In this system the cooling pipes are grouped in a room and large wooden conduits are used to convey the air to and from the rooms to be cooled. Fans are often used for this purpose so as to keep the air in circulation. This system is in use where fresh air is desired and where perishable goods are in storage.

Ice manufacture is simply one branch of refrigeration and in cooling storage space, the rooms to be cooled merely take the place of the freezing tanks in the manufacture of ice, and may be considered as a special application of the indirect system of refrigeration, although the direct system may be employed. In the brine system, the brine which is deprived of its heat is made to circulate in proximity to the water it is desired to freeze and as the freezing point of the brine is below the freezing point of water, it permits the circulation of the brine at a much lower temperature.

A "mill power" is a unit used to rate water power for the purpose of renting it. The value of the unit is different in different localities. In Holyoke, Lowell and Lawrence, Mass., and Manchester, N. H., it is equivalent to the amount of water that will give about 86 horse power. At Minneapolis, it is equivalent to 75 horse power, and in Cohoes, N. Y., it is equal to 13.6 horse power.

The capacity of pipes increases with the square of their diameter; thus, doubling the diameter of a pipe increases its capacity four times.

THE INCANDESCENT LAMP

Some Facts About its History, Construction, Candle Power and Life

In the utilization of the electric current there is no piece of apparatus which gives such little trouble, and which is more in evidence, than an incandescent lamp. As this small bit of glass-enclosed vacuum with its tiny red hot filament has done so much for the introduction of electric lighting and consequently the electric dynamo and the steam engine, it might be well to give a few points of its construction, some data in reference to its voltage and candle power, and some facts about its useful life.

Just who the inventor of the incandescent lamp is has always been a subject of much argument, although popular opinion and the decision of the courts have accorded it to Thomas A. Edison. As early as 1840, William R. Grove, who invented the Grove Battery, devised an incandescent lamp, and read by it for hours. This was followed by an invention of two men, King and Starr, in 1845, which came to be known as the Starr-King Lamp, and consisted of a pencil of carbon held together in a vacuum by the connecting wires leading to a battery. In 1859, M. G. Farmer, of Salem, Mass., was the first person to light a dwelling with a series of sub-divided electric lights, by passing the current through a number of electric lamps. In 1877, the lamp known as the Sawyer-Mann Lamp was invented by Wm. E. Sawyer, and consisted of an incandescent rod of carbon, which was enclosed in an atmosphere of nitrogen. This marked the beginning of great activity in this field, and resulted in the well-known form of lamp patented by Edison on January 27, 1880. The distinctive features of this lamp consisted of a bowed filament of very thin thread-like character, which was made of paper, or carbonized cellulose. This, when sealed in a vacuum, would not burn away, but would give the proper incandescence, and, by its small transverse dimension, and high resistance to the current, permitted a proper distribution of the electric current to a number of lamps, without a special regulator for each lamp; and which could be made so cheaply that the lamp could be thrown away when the filament was finally broken. Edison's claim was sharply contested in the Patent Office by Sawyer and Mann, with the decisions alternating first in favor of one, and then of the other, but which finally resulted in a victory for Sawyer and Mann in 1885. A struggle then began in the courts, which in 1892 awarded the incandescent lamp to Edison.

The lamp as perfected to-day consists of an entirely-closed bulb, a filament of carbon inside the bulb, and two terminals on the outside, to which the filament is attached by "leading in" wires, which pass through the glass, the latter being sealed around the wires. The name of incandescent is attributed to the fact that when current is passed through it, its resistance is such that the current raises its temperature to white heat or incandescence.

The carbon filament is made of cellulose, which is a solution of absorbent cotton in chloride of zinc. In this form it is a heavy, viscous, semi-transparent liquid. This is evaporated until it becomes as thick as molasses, and is then squirted through a fine nozzle, or forming die, into a tank of alcohol. This hardens it into a long, thin thread, which can be handled. It is then washed, dried and cut into proper lengths, after which it is carbonized at a very high temperature, care being taken that no air is admitted to the filament during this process. The filaments are then ready for the "flashing process."

When a filament has been carbonized, it is found that its cross section in some places is smaller than at others. The effect of this would be that the small section, having more resistance than the large section, would glow more brightly when current is passed through it. In the "flashing process," the carbon filament is allowed to come to incandescence in a hydrocarbon vapor. The heated surface of the filament decomposes the vapor, and carbon is deposited on the portions of the filament which glow the brightest, and the result is a filament which is uniform in resistance, uniform in brilliancy and more durable.

The finished filament is then mounted on the ends of two pieces of platinum, which have been previously sealed into a piece of glass, that ultimately becomes the enclosing part for the neck of the bulb. The bulb proper is then placed over the filament and sealed to glass piece containing the filament, as shown in Fig. 1. The bulb is then closed with the exception of the top, from which a tube extends, which is used for exhausting the air from the bulb so that a vacuum will exist around the filament. The air is withdrawn because if the filament was heated in air, the oxygen of the air would combine with the carbon and cause combustion, with the consequent destruction of the filament.

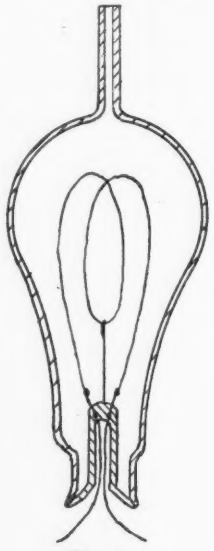


Fig. 1.
Cross Section of Lamp ready for Exhaustion.

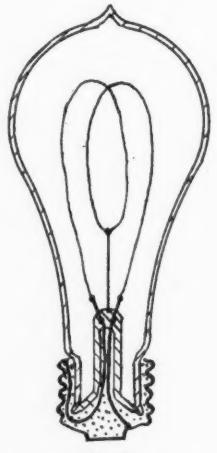


Fig. 2.
Exhausted Lamp with Base ready for use.

Another advantage obtained by putting the filament in a vacuum is that there is no heat-conducting medium between it and the bulb, so that all the heat that is generated in the filament goes to produce light, a very small portion being lost by conduction. If there was any gas or vapor within the bulb

it would conduct heat to the glass walls, and, consequently, give less heat to the filament for producing light. The fact that the bulb is seldom over 150 degrees, while the filament has a temperature of 2800 degrees, is proof that there is very little heat lost by conduction.

Notwithstanding the fact, however, that the filament is in a vacuum, the filament deteriorates or disintegrates. Just what causes this action is not exactly known, but small particles of carbon fly off from the filament and deposit themselves on the bulb, causing a gradual darkening of the glass, which, in old lamps, can be plainly seen. After the air is exhausted from the bulb with air pumps, any small amount of oxygen that is left is destroyed chemically, and the tube is sealed by heating the tube which forms the tip of the bulb.

The wires that lead into the bulb are made of platinum, because that metal has the same coefficient of expansion as the glass. If a metal were used that did not have the same amount of expansion, either the metal would expand too much and break the glass, or it would not expand as much, allowing air to enter. In either case, the result would be the destruction of the lamp.

The wires leading to the outside of the bulb are then connected to the metal base of the lamp and the glass cemented to the base by plaster of Paris, as shown in Fig. 2. There are different styles of lamp bases used, of which the Edison, the Thompson-Houston and Westinghouse are the most in use. The lamps are then tested to find at what voltage they will give the candle power for which they are intended.

Carbon when it gets hot differs from all other conductors of electricity inasmuch as its resistance decreases as the temperature increases, while with other metals, the resistance increases with the temperature. For this reason, the ordinary filament will have about one-half the resistance when hot that it has when cold. The lamps are therefore tested by bringing the voltage up to a point where they will give 8, 16, 32 or whatever candle power is required, they being labelled 8 C. P. at 108 volts, or 16 C. P. at 120 volts, or whatever combination is found to be the most desirable for a lamp.

The candle power that a lamp gives out differs with the position from which it is viewed, so that, generally, when speaking of the candle power of a lamp, it means the number of candle power looking at the filament broadside on or with the plane of the filament at right angles to the line of observation. This candle power is obtained by means of an arrangement known as a photometer, where the lamp under test is compared with some standard flame or light whose brilliancy is known never to vary. In the olden days, a sperm candle was the unit of light, which was supposed never to vary, and, for this reason, the term candle power has come to be so widely used. A sperm candle in reality is a very uncertain standard, so that a flame from a spirit or oil lamp is now generally used.

Since the illuminating power is rated in candle power, the power consumption of the lamp is stated in watts per candle power. This power consumption of a lamp is by no means constant, as it varies continually with the number of hours the lamp is in service. When a new lamp is put into circuit, it usually, for a short time, gives a somewhat greater candle power than that at which it is rated, usually about 6 per cent. to 8 per cent. more. This gradually falls off and the candle power is the lowest at the end of its life. This is plainly shown by the curve of a 16 candle power lamp shown in Fig. 3.

The decrease in candle power is not followed by a proportional decrease in the current, because the filament gradually wastes away, and this, together with the blackened bulb, causes the candle power to fall without materially changing the current passing through it, as the electro-motive force at the terminals is constant.

The efficiency at which a lamp is run affects both its candle power and life of a lamp, the efficiency depending upon the voltage at which the lamp is burned. If a lamp is burned at a comparatively high voltage, the number of watts required per candle power is less, but the life of the lamp is materially

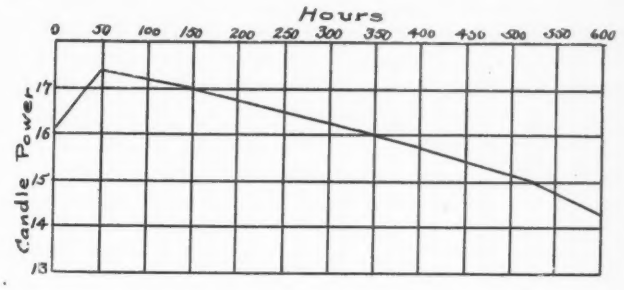


Fig. 3. Relation of Candle Power and Life.

shortened, but if the lamp is burned at low voltage, which will give the filament a dull, red appearance, then the life of a lamp may be almost indefinite, but the number of candle power obtained from the number of watts used will cause it to be very inefficient. For instance, suppose a 16 candle power lamp gives the ordinary efficiency of 3.5 watts per electro-motive force at 110 volts. Under these regular conditions, the life of the lamp may be about 600 hours. If the voltage is increased to 115, the candle power will increase so that the power consumed may be only 3.0 watts per candle power, but the life of the lamp may be lessened to only 300 hours. On the other hand, if the voltage was reduced to 105 volts, it is probable that the candle power would be so small that it would require 4.5 watts per candle power, but the life of the lamp may be under those conditions as much as 2000 hours or more.

Since the price of an incandescent lamp is now so small, this factor of candle power, life, and efficiency is one of supreme importance in the running of an isolated lighting plant. The conditions are something like these: A certain amount of power is generated to produce light, and a certain number of lamps are used to give out that light, and the question continually arises as to what is the best voltage at which to run the lamps. If run at a low voltage, the lamps will be dim and inefficient, but the life of the lamp will be very long and the cost of lamp renewals very small. If run at a high voltage, the lamps will be very bright and efficient, but the cost of new lamps will be great.

The choice of efficiency or voltage at which the lamps are to be run depends upon the cost of power. If coal is cheaper, it pays to burn the lamp at a low voltage and long life. If coal is dear, the lamp burning at high efficiency should be used, provided that there are no great fluctuations of voltage on the circuit at which the lamp is intended, which shortens its life very much. If all the exhaust steam from the engine is used for heating purposes, then it is desirable to use the low efficiency and long life lamps.

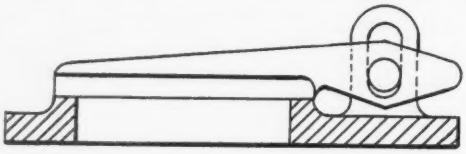
RECIPROCATING PUMP WATER VALVES

Types of Valves Used on the Water End of Pumps.

A pump with badly designed water valves is something like a man without his dinner—it will not work right—and a very large percentage of useful work will be lost if the valves of a pump are not constructed properly. What constitutes a correct valve cannot be said, as each form may possess some feature which will especially adapt it to some duty and while one form of valve may work successfully under certain conditions, it may be a complete failure under others. In general, valves can be divided into two classes: those that work on hinges, and those whose lift is vertical. The hinged valve is made to swing about a pivot at one side and the angle of lift is usually about 30 to 45 degrees. The vertical lift valve rises from its seat in line with opening of the valve seat and is held in place by guides, stops or springs.

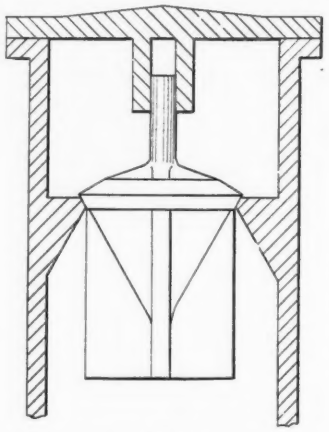
The principal forms of valves in use according to their shapes are (1) clack or flap valves; (2) mitre, mushroom, conical and puppet valves; (3) disc valves; (4) ball valves; (5) double beat or multiple beat valves; (6) India rubber, conical and lip valves.

The clack valve, known also as the flap valve, is a simple form of valve more largely used than any other. It consists of a disc hinged on one side, usually made entirely of metal, leather or India rubber, strengthened and weighted by plates



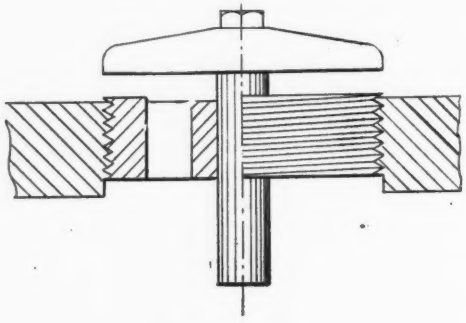
Hinged Flap Valve.

of iron, gun metal or lead. The object of the plates is to give the valve sufficient weight to close quickly, when the pressure of the water rising below the valves ceases. When two of these valves are placed back to back, and hinged on a spindle in the centre of the passage, they are known as butterfly valves. For ordinary lifts and pumps running at slow speed, clack valves are generally recommended as being simple, inexpensive to repair and trustworthy. They will also permit moderate sized obstacles to pass through them. The butterfly form of valve possesses an advantage over the ordinary clack valve of not interfering so much with the direct flow of the liquid being pumped, but it is rather more given to stick. It need hardly be said that whatever form of valve be used, it is a matter of great importance that the water should have as free a passage through the pump as possible, and it has been given as a broad rule that to be effective, the pump valve should be arranged with the water way at least equal to the area of the suction pipe. The valve to be desired is one which gives a maximum area of discharge for the water with a minimum area subjected to the downward pressure and consequent concussion at the end of each stroke of the pump. Ball valves are said to be the very best for this purpose, but they are only found suitable for moderate pressures. If clack valves are used for gritty water, they should be made of gun metal. Clack valves are usually arranged to lift to an angle of about 45 degrees to permit their closing themselves readily to avoid excess of "slip." Clack valves have the disadvantage of being rather sluggish in their action and close with considerable concussion, hence the amount of water slip renders them generally unsuitable for high speeded steam pumps.



Mitre Valve.

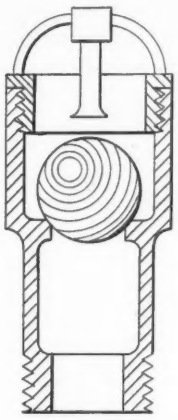
Mitre, mushroom, conical and puppet valves are made in a variety of forms of gun metal, India rubber, etc., the metallic valves being ground to fit accurately a conical opening in the seat. These valves hold water well when they are new but unless they are made with a low lift, the constant shock from their sudden closing will soon cause them to wear and leak. From this cause chiefly they have for large pumps been to a great extent superseded by double beat or multiple valves. Mitre valves are usually bevelled to an angle of 45 degrees and fitted with feathers and stop, to guide the beat of the valve.



Flat Seat Valve.

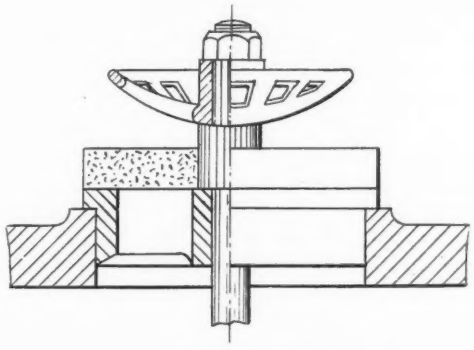
Valves of this type should be made as large as possible, to reduce the amount of lift required and consequent wear on the lowest point. Valve beats are made of iron, gun metal, lead, metallic compositions and various woods according to the duty required. If metals are used, the valves and beats

should be made of the same material to avoid galvanic action. If wood is employed for the valve seat, holly can be recommended. Valves of this type combine compactness with ready adjustment and quickness of closing but are somewhat given to clog, except in the case of some India rubber flexible conical valves, which will permit the passage of foreign substances. Springs are sometimes employed to expedite the closing of these valves.



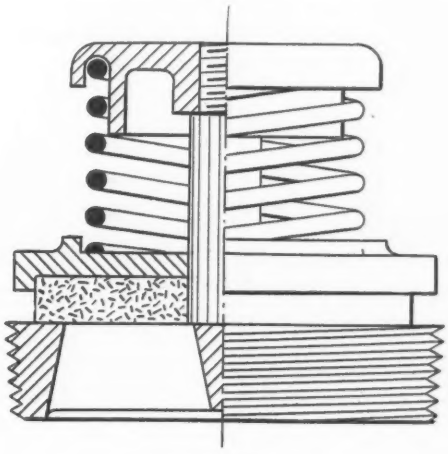
Ball Valve.

Ball valves are an extremely useful form of valve, as they are very simple and will last a long time if properly made and fitted. It is important to their effective working that the balls have a greater specific gravity than the water, so that they will close readily without much pressure; if they have not, they may be given to dancing, thus making a loss at every stroke of the pump. This is particularly the case when the suction is long and the delivery of water light. The balls are usually made of an India rubber composition, a metallic ball covered with India rubber, or of gun metal. If sufficiently heavy, the first is generally preferable to the second; owing to the difficulty of putting the metal exactly in the centre of the India rubber, they are apt to wear unevenly. A number of small valves are preferable to one or more large ones, as a much lower lift and consequent freedom from wear are secured; at the same time they are more readily repaired and should one get out of order, the pump is not disabled. The lift of these valves is regulated by a guard or cage. They can be recommended for use with heads of water not exceeding say 250 feet and will be found much lighter in action than most other forms of valves. The balls should work in gun metal seatings and if used for very hot water or long suction, they themselves should be of gun metal.



Flexible Disc Valve.

Disc valves are usually made of discs of India rubber or vulcanized fibre mounted on a small vertical spindle resting on a grid and covered with a perforated plate which acts as a guard and regulates the lift of the valve. India rubber being flexible and sensitive and being easily renewed makes an excellent valve for moderate lifts, as it readily rises and closes gently without shock, but it cannot be recommended for a greater lift than 250 feet. For large pumps, a group of moderate sized valves can be recommended in preference to one large one. These are somtims used with light springs fitted in the top of them to assist them in closing. The finest quality of rubber should be used, as it is less liable to crack at the spindle hole, which is sometimes the case with mixed rubber; but some mixed rubber has the advantage in weight and the valve will therefore close more readily. Rubber varying in thickness from ½ inch to 1 inch, according to the size of the valve, is used and a lift given to it in proportion to its diameter from say ⅛ to ⅜ of an inch. All corners in the grid and guard should be rounded carefully to prevent the rubber from cutting. Vulcanized fibre has of late been used considerably for valves in lieu of India rubber and it is claimed for it that the only effect that cold or hot water has upon it is to increase its flexibility. It is said also to resist the action of oils and is as equally adapted to a direct lift as to a bending or cup guard.



Flat Seat Spring Valve.

Double beat valves are used for large pumps, as they in a great measure get rid of the detrimental concussive action found in clack or conical valves, and the lift necessary is only about half that required by these valves. In the double beat valve, what is practically two valves exist, as at each lift of the valve two spaces for the passage of the water are opened and the valve beats on two seats. The valve is cylindrical and beats on rings or seatings usually connected together by radiating feathers or plates. The valves for large pumps are usually made of iron, beating on seats of holly or other close grained wood and if carefully designed and made, they will last a long time, and will work with very little leakage of water. It is very important, however, in designing valves of this type to secure their gentle closing and that the amount

of valve area subjected to the water pressure is carefully calculated and regulated according to the pressure.

India rubber conical and lip valves are used to a moderate extent and are made so that the water escapes either by the expansion or contraction of the India rubber. In the case of lip valves, the lips are forced open by the pressure of water and close themselves automatically through the natural elasticity of the rubber. A large variety of these valves have been designed, and for moderate duties some of them are very useful, but none can be recommended for high lifts. Whatever form of valve is employed, it is of the utmost importance that they should be allowed to seat themselves easily and without jar, or they will rapidly hammer and cut themselves away and require replacing. This is usually done by steam cushioning or reducing the speed of the pump at the end of each stroke. The kind of pump and the duty it has to perform are the chief factors to be borne in mind in determining the best form of valve to employ, each of the great number of valves made may possess some feature in its construction to suit it particularly to some special duty but no one form can be pronounced the best under all circumstances.

—o—

Where the Indicator Was a Good Investment.

By William F. Burdick.

The majority of engineers these days are familiar with the indicator and know how to use it, while there are others who do not think it any benefit at all and brag that they can set valves accurately without it and have done so all their lives. They say it is only the book engineers who take any stock in them and if they were practical engineers, they would not need the nickel-plated ornament.

Now the indicator is not used entirely for setting valves; "properly speaking" the indicator does not set the valves, the engineer or the erecting engineer does the setting; all the indicator will do in that respect is to convey to the operator whether or not they are set correct, when on the other hand, the indicator will tell you the actual horse power the engine is doing and the amount of back pressure she has to work against, or, the amount of atmosphere pressure removed, if running condensing.

Those engineers who do not believe in indicators may be practical and can set valves properly without the aid of an indicator, we will say for convenience, but if you should ask them how many horse power their engine is doing, they would say she is 12 x 36, perhaps, I am just taking this size for illustration, and is 75 horse power. The next question which would be asked is: What is her average indicator horse power? and the reply will be: "Don't know, never had one on, but she was sold for a 75 horse engine and she is doing every bit of it." The matter is only guess work with him who calls himself a practical engineer, and guessing is a thing of the past in the engineering profession.

I will now relate where the indicator was a great benefit and I was a witness to the whole affair.

A factory was to be started, and the people who were interested in it, purchased machines to manufacture their goods. There were six heavy machines with shafting and a few counter shafts to run small machines in connection with the larger ones. They asked the builder of the machines how much power the machines would take, as they wished to get an engine large enough to run them. Well, he estimated the large ones to take 25 horse power each, and the smaller ones altogether 10 horse power, making in all about 160 horse power. The question was then asked if a 150 horse power engine would be large enough and the answer was, "No, get a 250 horse power, as you may add on other machines some time in the future." A good Corliss engine made by a well-established engine builder was purchased and rated by the builder as 250 horse power. The engine was installed, connections to the boilers were made with the proper size steam pipe, also exhaust was proper size and was to discharge into the atmosphere or to be used for heating water, as may be desired, there being a back pressure valve placed in the exhaust pipe in the usual way. A pressure of 80 pounds was carried on the boilers. When everything was ready to start, the engineer in charge started the engine. After a few days, when everything in the factory was pronounced O. K., the load was thrown on the engine but she did not run long before she stopped entirely. The manager and superintendent came into the engine room, inquiring what the trouble was, and the engineer in charge informed them that there was too much of a load for the engine to carry; the reply was that the engine could take care of twice that load. The load was taken off the engine and started again, but with the same result. The safety valves were set down this time to carry 100 pounds on the boilers. The insurance company allowed them 120 pounds, so they were under the limit at this pressure the engine would run, but not at the speed intended. She was intended to run at 80 per minute, but could not get more than 65 or 70 revolutions, the governor being of no use whatever. The engineer being a new man to the manager and superintendent, they were under the impression that he did not know his business, for surely the man who built the machines knew what power they would take; making it anything but pleasant for the engineer who was trying to operate the steam end of the plant. After a few days running in this way, one of the mechanics who came from out of town to help install and run the machines after installation, went to the engineer and said that the engine was no good, as there was not 150 horse power on her and she was bought for a 250 horse power engine. The engineer replied that she was doing 300 horse power if she was doing anything. The mechanic said he was crazy and did not know what he was talking about. This touched the engineer's vital spot and he went to the superintendent and asked him if he was not satisfied that the engine was overloaded, as he knew there was an overload somewhere but could not tell where. The indicator was applied by the engineer in charge, and showed that the valves were set properly, the card figured out that the engine was doing 302 horse power with 15 pounds back pressure. This opened the superintendent's eyes and he said it could not be possible. He was informed if he indicated the machines separately he would find out where the overload was. He said it was a good scheme and we would do it. They arranged the next day to indicate the engines and find the horse power of each machine, and found the machines that were estimated to take not over 25 horse power were taking 89 horse power when they were worked to their limit, and 50 horse power when working moderate. This evidence convinced them that they were buncoed by the concern who sold them the machines and their manager was sent for to explain matters. He did, by saying the engine was no good because if she was she could run away with that load; at any

rate he wished to have the factory shut down for a few days so that he could go over the machinery. This was done and every machine was examined, also the shafting, to find out if possible if they could be run with less power. When he considered them in perfect condition he insisted on having an expert on indicating engines called in to indicate the engine. The expert was secured and the engine started. Cards were taken by the expert with the same result as before, the engine doing over 300 horse power with the machines working to about one-half the capacity they were intended for.

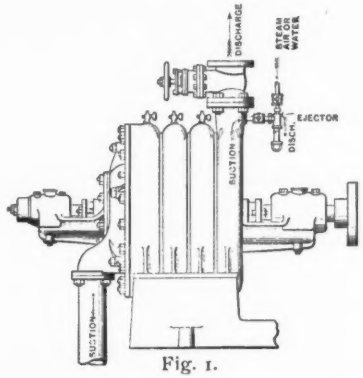


Fig. 1.

The outcome of the matter was, that the machines were taken out and are now rusting away out in a lot beside the factory, never to be used again except for scrap iron. Other machines were put in to replace the ones taken out, but of a different make, which take 35 horse power when worked to their limit, doing more work than the others. The engine is now worked to her capacity, doing from 210 to 265 horse power, the average indicated horse power being 237.5.

If the engineer of this plant was a so-called practical man with no knowledge of operating the indicator, he could tell the engine was overloaded. There is no doubt about that, but

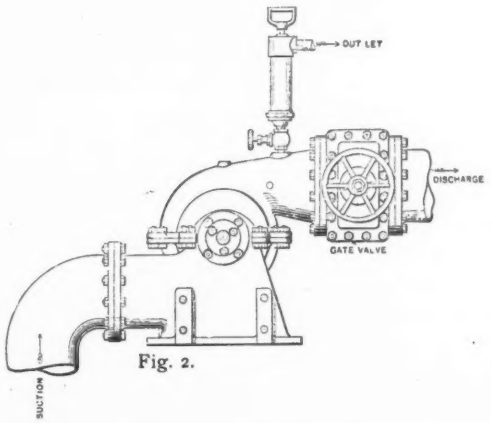


Fig. 2.

he could not prove it, which the indicator did, and that was a matter of great importance in this case.

The engine of this plant is indicated once a week since, and sometimes oftener, and if this firm was to hire an engineer, the first question to be asked the applicant would be: "Do you know how to indicate engines?" and I think they would be justified in asking such a question, for if it had not been for the indicator, the engine might have been condemned and would have been taken out, causing expense. A new one would have to be built, perhaps, for, as a rule, engines of this size are not carried in stock. A new foundation would also have had to be built for the new engine to set on; all this with the time lost would amount to several thousand dollars to the company. Not mentioning the expense that would be incurred in full, I think this article a fair illustration of the difference between an engineer who understands the indicator and the one who has no use for it. I consider a man not a practical engineer unless he possesses that knowledge and makes use of it.

Methods of Starting Centrifugal Pumps.

Before starting a centrifugal pump, it is necessary to fill the casing and suction line with the fluid to be pumped, as machines of this kind will not create a vacuum of any amount without first being primed. Numerous devices are employed for this purpose but the accompanying illustrations show the methods that are most generally used.

Fig. 1 illustrates a multi-stage turbine pump which uses an ejector for priming. The ejector is connected to the highest point on the pump casing and either steam, air or water under pressure may be employed to produce a vacuum.

Another method which uses an auxiliary hand pump is

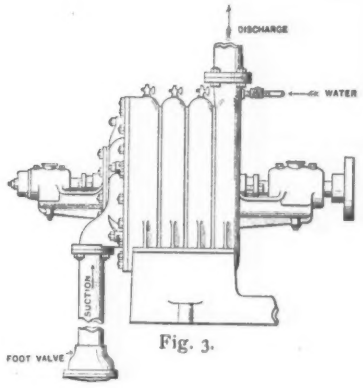


Fig. 3.

shown in Fig. 2. When the pump is ready to start, the gate valve on the discharge is closed, and by operating the hand pump, a vacuum is produced and water drawn in, filling the suction pipe and casing.

The method of priming shown in Fig. 3 may be resorted to where a foot valve is used on the suction pipe. Water is allowed to run into the pump until it reaches the discharge flange, when the supply is shut off and the pump may be started.

After the pump has been properly primed, it should be started before the gate valve on the discharge is opened. When full speed is reached, the discharge gate may be slowly opened, and the pump will perform its work in a proper manner.

The suction line must be free from air leaks and if more than twenty feet in length, it should be larger than the pump suction to avoid undue friction. The discharge line must be of sufficient size to remove the water without excessive friction loss. A gate valve should be located in the discharge pipe near the pump.

The Practical Engineer

PUBLISHED ON THE FIRST OF EACH MONTH

L. L. RICE, Proprietor

46 North Twelfth Street **Philadelphia, Pa.**

The Practical Engineer is devoted to the economical generation and utilization of power for the industries.

Articles upon subjects of interest to engineers, will always receive our very careful attention.

The little things are often most valuable, therefore, we especially solicit short articles on the small problems met with in daily practice. When illustrations are desirable a pencil sketch is sufficient.

Address all Communications and make all Checks, Money Orders and Drafts payable to

The Practical Engineer

46 North Twelfth Street **Philadelphia, Pa.**

SUBSCRIPTION RATES in the United States, Canada and Mexico, Fifty Cents the year, in advance.

FOREIGN SUBSCRIPTIONS to countries within the Postal Union, postage prepaid, One Dollar the year, in advance.

Entered at Philadelphia Post-office as Second-class Matter.

Speed of Boiler Feed Pumps.

In going around among small plants, one often sees in some plants the boiler feed pump apparently running a race, and in other plants, the pump running very leisurely, and the question arises as to which is the better condition of affairs and what is the best speed to run a reciprocating pump.

Very often this question cannot be answered as the pump must sometimes be run according to existing conditions over which the engineer has no control. Usually, however, in the small plant, the reciprocating pump is made much larger than necessary and it can either be kept continuously running at a slow speed or it can be run very fast for short periods and then shut down.

If the pump be run continuously at a slow speed it is a self-evident fact that no great quantity of comparatively cool feed water is injected into the boiler at one time and consequently the water level is kept constant and the internal boiler strains and the interference with the steam pressure is the least.

If the pump be run at intervals, there is less waste of steam due to leakage around the steam and water cylinders of the pump and consequently it runs at a higher efficiency. That this waste of steam does take place is shown by the fact that some pumps, if not in the best condition, will not pump at all when run slowly. When the pump is run at high speed at intervals, the temperature of the feed water depends to a large extent upon the size of the feed water heater. If not more than the quantity of water that will stand in the heater is pumped at one time, then the temperature of the feed water will enter the boiler at its maximum temperature, but it is not always possible to allow the water to stand and warm in the heater before pumping and it is not always convenient to pump the water in the boiler when it becomes warm and besides, this requires constant attention.

In general, then, it may be said that the speed at which a feed pump should work depends upon conditions. If the pump is of large size with the feed water heater of large capacity then it would probably be better to pump fast and intermittently, but when the pump is small, it is better to pump at a more even gait. Conditions will not always permit this, but the thing to be kept in mind is the efficiency of the pump and the quantity and temperature of the feed water pumped.

—o—

Fallacies and Facts of the Laws of Science.

We have recently received from one of our readers, a full-page newspaper account, cut from one of the Sunday editions, of a machine that is said to be able to warm the largest building in the coldest weather without any combustion of coal or wood, the heat being produced by friction. This article would have found its way to the waste-paper basket in about two minutes except for the fact that our correspondent would like to know what we think about it and what lesson it teaches.

Before going into the discussion of it, an account of the "wonderful machine that will revolutionize the world" might prove interesting. It consists of "a steel tube surrounded by a water jacket, and inside of the tube a wooden roller cut into four rectangular sections and arranged about a steel shaft. The wooden roller is 5 inches in diameter and the inside of the tube, in which it runs, is 6 inches in diameter. The water chamber outside the tube is 10 inches in diameter, leaving 4 inches for the water chamber. The machine is driven by a motor which revolves the wooden roller. The roller heats the surrounding air, the air heats the tube around it, and the tube heats the water and thus completes the process necessary to the practical success of the invention." How simple! how easy! how ignorant must have been Watt, Stephenson and our other inventors not to have thought of it!

The account then grows mysterious: "Although it has not been explained on any reasonable theory, yet it is a fact that the wooden roller by which this heat is produced is not burned in the slightest and after nine months' use does not show the slightest wear. The only theory advanced in explanation of this is that a cushion of air forms between the wooden roller and the inside of the tube and prevents the heating of the roller and the wear that would naturally follow when it is turned at such a high rate of speed."

While this might seem wonderful, it is not to be compared to the results it will produce. Quoting from the article again it says: "A two horse power motor is now used to operate the machine and the tests have shown that at a speed of 700 revolutions per minute, it will heat 990 gallons of water to a temperature of 160 degrees in 55 minutes. At the rate of 700 revolutions, steam is produced in 5 minutes from the instant the machine is started and during the next 45 minutes steam is made at the rate of a pound a minute. From that time on there is a gain of 10 pounds of steam every 3 minutes. It has

been shown that the machine will produce a wonderful gain of 200 pounds of steam in one hour. This machine will produce steam enough to run itself and in addition heat a large building and a three horse power motor has been run by it when only a two horse power power was required to run it," etc., etc.

It is evident without going further what kind of a machine this is. Barnum once said that the American people liked to be humbugged, and proceeded to do it by painting one of his elephants with whitewash, and thousands flocked to see the only living white elephant in existence. Keeley, a so-called inventor, followed in Barnum's footsteps by announcing that he solved the mysteries of perpetual motion, and with a bucket of water and a piece of rope he proposed to move the world. It was one of the most gigantic swindles ever launched upon the public and while many people from all over the country went to see his apparently simple mechanism, which seemed to work as he said, it was found upon his death that the reason the bucket of water and piece of rope did what it was said to do was because he always had a small boy behind the scenes to turn the crank.

There is one thing that is fixed and that is, that both the amount of energy and the amount of matter on this small earth are always the same as they have been, notwithstanding periodic claims to the contrary, and we had better believe that matter and energy cannot be created or destroyed, but only changed in form, than to take stock in a machine that, in the shades of the laboratory, will give an efficiency of 150 per cent.

—o—

Smoke and its Prevention.

There is such a divergence of opinion about the economy of burning smoke that, in some instances, some of the arguments advanced in its favor and some of the claims as to the economy of burning the black gas are laughable, and it is evident that many of the inventors and promoters of this class of apparatus have never given sufficient attention to know why bituminous coal produces smoke or what are the essentials for preventing it.

The principal elements in coal that give it its heating power are carbon and hydrogen. When a pound of pure carbon is completely burned, it will give out 14,500 heat units, and when a pound of pure hydrogen is burned, it will give out 62,500 heat units; but as the chief heating value of a coal is the carbon it contains, the heating value of fairly good coal usually hovers around the heating value of one pound of carbon or 14,500 heat units. One reason why the hydrogen in the coal does show up in the heating value to any great extent is the fact that hydrogen will always combine with the oxygen in the coal or air to form water, which must be decomposed in order to make it of any heating value. If there is no excess of oxygen present, the hydrogen in the coal will combine with the free carbon and give a compound known as a hydrocarbon. It is these hydrocarbons that give most of the trouble in burning bituminous coal.

When this gas goes up the chimney unconsumed there is undoubtedly some waste of heat, but not nearly so much as is often claimed for it, but still enough to make every one strive to prevent it. The actual loss of heat, by reason of this wasted gas that passes away in smoke, amounts to from perhaps 5 to 20 per cent. in a majority of plants. It certainly appears more in a greater majority of instances but on account of its light weight per cubic foot, its actual calorific value is but a small percentage of the calorific power of the coal.

While the proper preventing of this smoke will undoubtedly increase the efficiency of the furnace, it is the unscientific methods employed to burn it after it has been formed that has given the name of smoke consumers such a black eye. In an ordinary hand fired plant, where smoke necessarily accompanies strong firing, there is often a greater waste due to excess of air admitted in the usual processes of shoveling in the coal, slicing and cleaning fires than in the waste heat in smoke.

The prevention of smoke, to be a success commercially, must therefore provide not only for the complete combustion of the fuel, but also for avoiding the unnecessary excess of air due to many causes. This air so cools the temperature of the flue gases as to make combustion impossible.

One of the chief reasons why smoke is produced is on account of poorly designed fire boxes. The temperature of a good fire is about 2500 degrees Fahrenheit and the temperature required to ignite the volatile or smoke producing portion of the coal is at least 950 degrees. So long as the gases from the fire are allowed to strike the comparatively cool heating surfaces before they are completely burned, so long will smoke be produced. The temperature of the inside of a boiler is usually, at the most, about 350 degrees, so that when the burning gas is allowed to come into contact with the heating surfaces, which have water on the other side, the decreased temperature not only extinguishes the flame but causes a deposit of soot on them, thus not only preventing the production of the full amount of heat from the fuel, but also preventing full absorption of the heat produced. Perfect combustion and heat absorption by the water surfaces cannot go on at the same time in the same place, and the result is smoke.

The mechanical stoker, as a general rule, prevents the formation of smoke, as it eliminates the personal equation by regulating the amount of fuel fed in and the amount of air necessary for complete combustion and it fulfils the necessary conditions of allowing the coal to coke, the combustion of the volatile gas being obtained by allowing it to pass over the hot bed of the coke before it goes into the flues and at the same time breaks up the clinker without the opening of the fire doors.

If as much money was spent upon the fireman as is spent upon smoke devices, there would not be so much complaint about the smoke pouring out of the chimney. A good fireman can, with a properly designed boiler, prevent smoke, but he must use judgment about how to clean and when and how much coal to shovel and stoke. The proper thickness of fire to carry on the grate must be varied according to the character of the coal, the strength of draft, and the rate of combustion required to produce the requisite amount of power must also be determined by the judgment of the fireman.

The trouble is, in a number of instances, at least, that the fireman is supposed to work from ten to twelve hours a day and possess all this knowledge that many of his superiors do not possess, but when his pay comes around, he has the flattest looking envelope and the smoke goes up the chimney just the same.

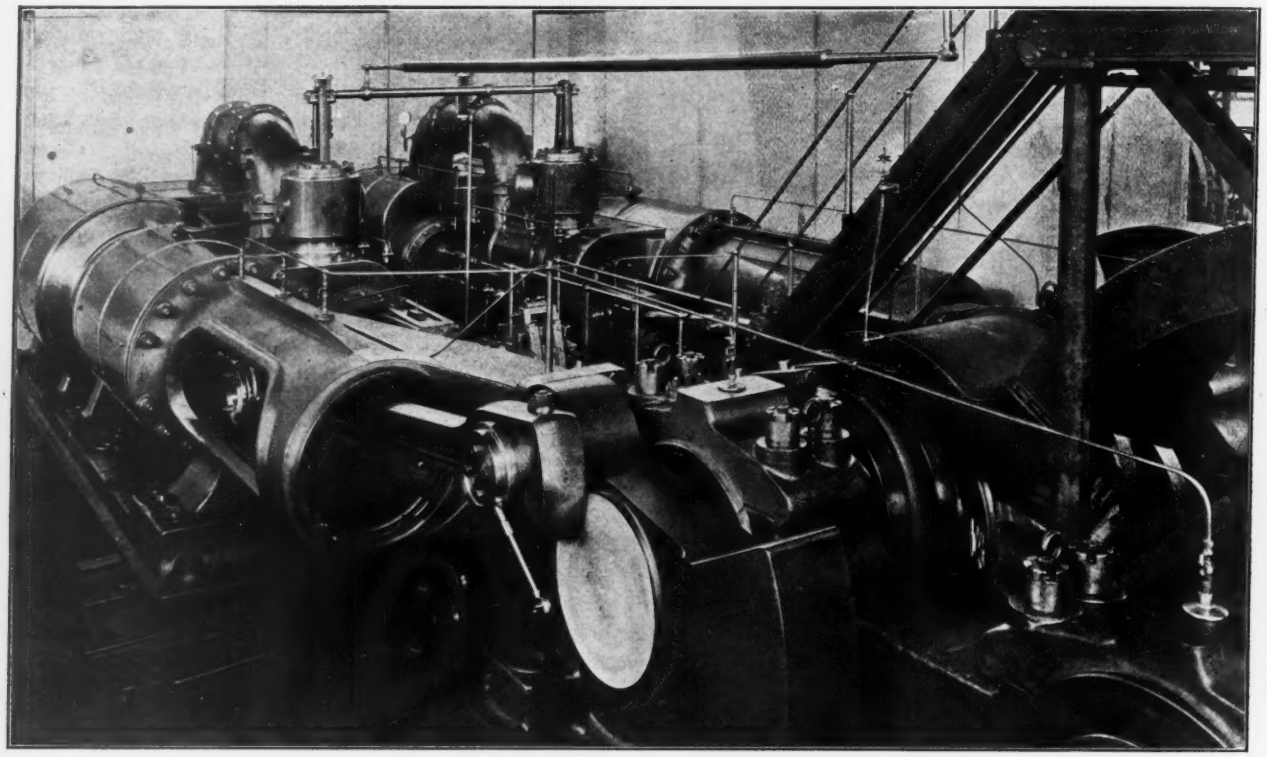
ROLLING MILL ENGINES

Some Advantages of the Rottmann Valve Distribution

By A. Gradenwitz.

Steam engines without fly wheels are still being regarded as most advantageous for working heavy double or triple trains of rolls, because of their ready adaptation to the wants of the rolling process and their easy manipulation. Moreover, they avoid the great drawback inherent in fly-wheel engines, which by their continuing to run in pauses where no work is being done, give rise to an unnecessary waste of steam.

Now there are two systems of such engines according as they are built either as triple engines, or, according to the twin system with simple or double expansion, being coupled to the mill either directly or by the intermediary of a toothed wheel gearing; the latter is mostly adapted for driving heavy finishing trains, although the twin reversing engine can also be used in this case.



Twin Reversing Rolling Mill Engine with Rottmann Valve Gear.

Triple engines consist of three equal cylinder systems with crank shafts set at 120°. On account of their uniform torque they allow of low steam admission being used, while being remarkable for their easy manipulation. Another advantage is the fact that they possess a high amount of reserve energy, as a similar engine has often been proved to do nearly the same work with two cylinders as it did before with three cylinders. Where the engine has to be run with two cylinders, there will be no alteration necessary in the position of the crank shaft or in any other respect. Whereas, with high steam pressure and connection to a central condensation plant the ordinary triple engine can also be used advantageously with low steam admission, there will for heavy work be at one's disposal a considerable capacity for increasing the initial momentum as well as the working area. In case of the heavy finishing mill being also used for smaller girders, arrangements can be made so as to allow of the triple engine being run as three cylinder compound engine for lighter work.

Twin reversing engines with tooth-wheel gearings are on the other hand always used in connection with heavy blooming or plate mills. On account of the small speed required in the case of such mills on the rolling process being commenced, a high gearing ratio should be chosen and the engine designed for high speeds. Reversing engines with toothed-wheel gearings for this purpose were so far principally supplied as ordinary twin engines, either with or without condensers. As higher steam pressures and condensing plants were adopted, the compound system, however, proved more satisfactory.

Special regulation gears are necessary to insure the advantage of the compound system at the starting. Instead of throttling the working steam before it enters the cylinder, as in the case of ordinary twin engines, both the high pressure and low pressure cylinders are furnished with a throttling valve, being connected in such a way as to be dependent on each other and

to be worked by one handle. Among the advantages afforded by this regulating valve there is an economical steam consumption and the possibility of stopping the engine instantaneously, while having a large amount of steam ready for use in the receiver when restarting.

This arrangement is greatly improved upon by the so-called Rottmann valve distribution, which while possessing the advantages above-mentioned allows of the effect of steam expansion being utilized to much greater advantage. This is done by connecting the regulating valve of the high pressure cylinder with a specially-designed expansion valve gear of the low pressure cylinder in such a way as to have their movements carried out with a certain amount of mutual dependency, both being worked by the same hand lever. In ordinary work, the expansion of the low pressure cylinder is adjusted to the correct steam admisssion, being approximately equal to the volumetric ratio, without bringing the connecting link into operation. With higher loads, the steam admission of the low pressure cylinder increases up to the maximum allowed by the distribution slide valve, this resulting in a better distribution of the steam expansion between the high and low pressure cylinders, whereas, the low pressure cylinder would have to do the greater part of the work alone. The steam diagrams show highly economical results when the engine is lightly worked, indicating that in the case of the regulating valve of the low pressure cylinder being further closed, the steam admission of the low pressure cylinder will no longer take the entire steam from the high pressure cylinder, there being no drop of pressure and no throttling, while the pressure in the receiver rises in proportion and the diagrams show clear lines of expansion. Now, if a heavier load be put on the engine, there will at once be a higher pressure ready to enter the low pressure cylinder, without there being any necessity for sending additional steam to the receiver. If the regulating valve of the high pressure cylinder is entirely closed, the valve gear is at low or zero admission point, and the steam enclosed in the receiver cannot therefore continue its activity. The engine is brought to an immediate standstill, the enclosed steam being not lost but ready for use when restarting. There is no loss of steam, should the load be accidentally thrown off, while the highest economy in steam consumption is attained by utilizing the expansive power of steam. Any intermediate output may be obtained economically, no matter whether the engine has to continue working in the same or in an opposite direction.

An interesting instance of the advantages afforded by the Rottmann valve gear is given in the following:

In a Westphalian Steel Works the steam consumption of a twin reversing engine, 60 inches diameter, 50 inches stroke, driving a finishing mill of 30 to 35 inches diameter, having been found to be too high, it was proposed to compound the engine by adding two low pressure cylinders to the two high pressure cylinders, to fit it with Rottmann valve gear and so convert it into a twin tandem reversing engine. By supplying the existing two cylinders with a lining, their diameter was brought down to 50 inches, while the diameter of the new low pressure cylinders was fixed to be 72 inches. The result of this reconstruction was guaranteed to be a reduction in steam consumption of 4.13 pounds per revolution of the engine.

The reconstruction was effected last January and tests were made shortly afterward, which gave the following results: The saving in consumption of steam was ascertained to be: 18½ per cent. for little duty, 30 per cent. for the average duty, 45 per cent. when rolling heavy pieces. These savings were calculated from the diagrams of the engine before and after reconstruction, under equal circumstances. During the normal working of the reconstructed engine these savings were found to be actually from about 20 to 30 per cent.

When taking the saving to be 25 per cent., the reduction in steam consumption, according to the diagrams, will be 4.4 pounds per revolution of the engine. For rolling a rod, 200 to 250 revolutions of the engine are required. Thus the reduction in the steam consumption will be from 880 to 1100 pounds per rod, or on the average 990 pounds. When assuming 400 rods weighing each from 2200 to 4200 pounds to be rolled in a day of 24 hours, the saving in the steam consumption will amount to 352,000 pounds per day. Taking the price of the steam to be 50 cents per ton of 2240 pounds, this means a saving of no less than 80 dollars per day, and for a year of 300 working days, the reconstructed engines in the present case will give a saving of 24,000 dollars per year. Compared with a non-condensing twin reversing steam engine, the savings of the reconstructed engine would, of course, be still greater.

Electricity in Textile Mills.

A paper on this subject was recently read by Charles Robbins at a meeting of the New England Cotton Manufacturers' Association. It describes the advantages of a constant speed of rotation in textile mills, but the larger part of the paper is of interest generally, as steam turbines and engine economy are discussed, as well as power distribution. Some of the most interesting facts are as follows:

The importance of constant speed in spinning and weaving is well known. Good work and a maximum production depend upon constant speed, and it is the universal opinion that should the smallest variation in speed take place in the engine or shafting it will seriously affect the operation of the spinning and weaving departments.

When the first alternating current generators, for use in connection with existing steam engines, were built and operated, it was found that a single machine would operate with entire satisfaction; when, however, it became necessary to operate two machines together for increased capacity, or in what is technically known as "in parallel," there developed conditions which caused a periodical transference of the load from one generator to the other. Electrically speaking, this is known as "hunting." After carefully investigating the causes which produced this result it was found that the engines had a periodical variation in rotative speed during each cycle of operation. This trouble was due to the angularity of the connecting rod and to the extreme variation of torque upon the shaft at each piston stroke. This condition led to the study of the subject by engine builders so that at the present time they are able to furnish an engine for driving electric generators which do not vary more than 1-30 of a degree from absolutely uniform rotation, which engines are usually heavier and of a higher speed than found ordinarily in mill work. This "hunting" in a mill engine is similar to a see-sawing process, a surging forward and backward, which is still further amplified by belting, and when transmitted to the spinning frame has a tendency to break the threads resulting in a decreased production of yarn.

It is evident therefore that an engine or turbine for operating an electric generator will furnish a more uniform and steadier speed than the regular mill engines, and if this uniform speed is available at the spinning frames and looms, that an increased production with a more uniform quality of work must result. In so far as observation goes this is true. Electrically driven mills undoubtedly turn out more work and of a better quality than those driven by mechanical means.

The ideal power plant is one that is so laid out that each unit is working at its maximum efficiency at all times, requires a minimum amount of attendance, occupies the least possible space, at the same time of such a design that it may readily be extended and when so enlarged have any or all generating units supplying power to any and all points, irrespective of location of power, demand or distance. This condition is best met by electric transmissions.

If electricity is adopted as a method of transmitting power, the plant may be installed at the most convenient point, which may or may not be attached to the buildings, or it may be placed any reasonable distance from the mill, thus permitting the mill to be located at a point which is most desirable on account of land, transportation, help, light, etc., whereas the power plant may be installed with a view to its location as a power generating station, irrespective of the point where the power is to be used, thus rendering available many water power developments which could not otherwise be used commercially.

The enormous use of electricity as motive power in street railways, in industrial establishments of all kinds, and by electric lighting companies, demanded the most economical generation of power in the prime mover and to-day engines and steam turbines are in operation using much less steam per horse power than was considered possible a few years ago. Therefore, it is fair to credit the use of electrical power with some of the great improvements now existing in steam apparatus.

Owing to the intimate relation existing between steam turbines and electrical distribution of power, it seems proper that we should discuss briefly this subject of steam turbines. The first commercial development of the steam turbine took place in England in 1884, by Charles A. Parsons, and within four years turbines of an aggregate capacity of some 4000 horse power were in operation. Up to the present time approximately, 200,000 horse power are in operation throughout England. It was not until 1898 that the Parsons turbine was introduced in America by the Westinghouse Machine Company. An estimate which is conservative, places the combined use of turbine generators now installed at about 300,000 horse power, and on order one-half million horse power additional.

The turbine development is by no means confined to a single company, it having been taken up in this country by several manufacturers, two of which were organized to manufacture steam turbines only and the other companies have been manufacturing steam engines. It will, therefore, be seen that the engine builders realized the rapidly increasing demand for steam turbines which in the end will materially affect their production of reciprocating engines, and for this reason are taking up this form of prime mover.

The partial success of the steam turbine as a power generating device lies in its extreme simplicity, it having a rotary motion without reciprocating parts, and owing to the high speed at which the turbines run, the moving elements are much lighter than those existing in steam engines of equivalent capacity.

An important detail in connection with the turbine is that no internal lubrication is required, consequently the condensed water may be returned directly to the boiler; thus, the cost of feed water and the necessity for a purifying process is eliminated. It follows, therefore, that considerable saving in operating expenses is made as well as the item of cylinder oil, while the cost of bearing oil is really insignificant.

In a particular instance on which data has been obtained, after several years of operation the cost of oil for a 600 horse power turbine is approximately five cents per day of twenty-four hours, which we believe is hardly ten per cent. of that usually required by a reciprocating engine of equivalent capacity.

The space occupied by the horizontal type of turbo-generator is in the neighborhood of .6 of a square foot per electrical horse power, or, to state it another way, approximately two-thirds of that required by the vertical type, and one-fifth of that required by the horizontal type of piston engine of the cross-compound Corliss type operated in connection with Condenser. The height of the turbine is about two-thirds the height of the horizontal and three-tenths of that of the vertical engine.

Owing to the uniform rotary motion and perfect balance of the turbo-generator a foundation of only sufficient size and depth to support the weight of the outfit is required, it not being found necessary to use foundation bolts. It is, therefore, apparent that a very large saving in the cost of foundations is made when compared with Corliss engines of either vertical or horizontal type. The steam economy of the turbine is another of its important factors and it is well to know that this does not vary much with the size of turbine.

A further feature which is of considerable importance in some classes of work, perhaps not pertinent to cotton mills, is that from half load to 125 per cent. load the steam consumption is almost a straight line. In a recent test made on a 600 horse power Westinghouse-Parsons unit by a well-known firm of engineers some interesting performances were shown, and as it is fairly representative of the operation of the steam turbine, we have made some extracts from this test.

When operating with 26.9 inches of vacuum and with dry saturated steam at 150 pounds pressure a water rate of 14 pounds per brake horse power was observed. By increasing the vacuum to 28 inches the water rate was decreased to 13.63 pounds per brake horse power, which was further lowered to 11.17 pounds per brake horse power by the use of 180 degrees superheat. It will be seen that the gain due to 1.1 inches vacuum at full load was 2.4 per cent. and the gain attributable to 180 degrees Fahrenheit superheat, 10.5 per cent. The thermal efficiency obtained in this test for dry saturated steam was 17.22 per cent. and under the same conditions with superheated steam, 19.43 per cent.

In another test, under regular operating conditions on a 1500 kilowatt turbo-generator, the steam consumption was found to be 14.23 pounds per electrical horse power, and the corresponding coal consumption 1.23 pounds per electrical horse power, using steam at 155 pounds pressure, 42 degrees Fahrenheit superheat and 27 inches vacuum.

Still another test, on a similar turbine but with 28 inches vacuum and 140 degrees Fahrenheit superheat, developed a water rate of 12.66 pounds per electrical horse power, which is equivalent to 10.75 pounds per indicated horse power on the basis of a total efficiency of 85 per cent. for the generator and steam engine.

It is a well-known fact that steam engine economy is dependent upon the excellent condition of the engine, and to maintain this condition it is necessary to take frequent indicator cards and to make adjustments of valves, piston heads, etc. The economy of the steam turbine does not seem to be affected by years of use. Observation has shown that there is practically no wear on the bearings whatsoever, seeming to show that the friction load in the turbine is very small.

Owing to the small size of the steam turbo-generators, the cost of building and the space occupied thereby is materially lessened as compared with other forms of engines and generators, and it is interesting to note that a great many manufacturers have installed turbo-generator auxiliaries in connection with their main steam engines in a space which, while sufficient for the turbine outfit, was inadequate for a new engine.

The alternating current motor has the widest use in textile mills for the reason that its design is so simple, in fact, consisting of only three main parts: the stationary portion, the revolving element and the bearings. There are no moving electrical contacts and as a consequence the only attention required is to keep the motor clean and to propery fill the self-oiling bearings.

One of the characteristic features of an alternating current motor is its automatic regulation, requiring power only in proportion to its output and being capable of sustaining, should occasion demand, large overloads without injury. Owing to the inherent design of this type of motor, the uniform rotative speed of the prime mover is available at the work just as though it were directly geared, and thus a gain in production resulting from a steady and even speed.

The question of sub-division of line shafts is one that is best disposed of by taking up each individual case and selecting motors of such capacity that a minimum amount of belting and auxiliary shafting will be required, at the same time reducing the friction to as low a factor as is consistent with a proper financial outlay.

Where the electric system is used, a factor of value in some instances is that if a break-down should occur, only a small portion of the mill would be affected, and such sections as it may be desired to run independently can be so operated without respect to any other and without operating main drives as is found necessary with a mechanical system.

On account of the general improvement in textile machinery, many mills have found that an increased production could be obtained by running their machines at a higher speed, involving an increase in the speed of the line shafts. While this can be accomplished successfully by changing pulleys, the increased speed means an increased demand upon the engine and oftentimes, due to the lack of capacity, this condition could not be complied with on account of the increased cost all along the line; whereas, if electric motors were used for driving the shafting it would be a small matter to change the size of the motor, and if the increase in speed is general it may involve an increase in the power house which can be accomplished by the addition of a new generator unit much more readily than by changing the engine in a mechanical drive.

In a small mill where it is known with a fair degree of accuracy that the conditions will not change and where the character of the product is such that no change in speed will take place, a mechanically driven mill with a centrally located steam engine will undoubtedly be as economical and its initial cost less than an electric installation.

In other instances, mills are laid out with a view to extensions, and on account of the inflexible conditions existing in engine driven mills, a large engine has been installed operating at from 50 to 60 per cent. of its rated capacity, which sometimes means that a single cylinder of a cross-compound engine is installed and that during the early operation of the mill the power plant must be running at an uneconomical load, which of course greatly increases the cost per horse power per year. The main shaft and transmission details must be of such a capacity that they will transmit the whole power should occasion demand it in the future. This involves a large initial outlay upon which interest, depreciation and insurance are increasing the operating cost per horse power.

There are other mills consisting of a number of buildings, each having its own power plant and inflexibly connected to its own lines of shafting, and therefore unable to supply power to any other building or to help out in the event of other engines being under-loaded, over-loaded or disabled; thus some of the power plants are running at uneconomical loads together with increased attendance, repairs and maintenance, also greater space required by the several plants that might be profitably used for manufacturing purposes if a single power plant were possible as with the electric drive.

There are now in operation in textile mills, electric motors aggregating in capacity 140,000 horse power. It will, therefore, be seen that in view of the comparatively recent introduction of the electric motor in this industry it is making rapid strides as a means of power transmission.

Coating for Iron Pipes.

When used in exposed places, iron pipes should be coated to prevent rusting and deterioration. A mixture of coal tar and pitch oil is used for this purpose in the proportion of one part tar to three of oil. The mixture is heated to the boiling temperature of the oil, and the pipes are immersed in it and allowed to remain until it is at the same temperature as the mixture. The pipes are then withdrawn, the naphtha and other light evaporating so that while still very hot, a firm hard coating of pitch is left, which firmly adheres to the iron. Care should be taken not to overheat the mixture, for if it is made too hot, the pitch will be overheated and afterward scale off.

When air is compressed, the compression develops heat and as the compressed air is cooled down to the temperature of the surrounding atmosphere before it is used, the mechanical equivalent of this dissipated heat is work lost. This loss of work is entirely unavoidable, the advantage of compression being to bring the energy of the air into more available form.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Opening and Closing Valves. A. T.'s Reply to Mr. Wakeman.

EDITOR THE PRACTICAL ENGINEER:

It seems that the subject of "Opening and Closing Valves" is causing quite a discussion among the readers of "The Practical Engineer," as a number of letters on this subject have been published. I had no idea when I was writing my article on valves in the June issue of "The Practical Engineer," that it would cause such a discussion. I expressed myself as I felt was surely right from the experience I had with valves and as I had seen them used, and in a number of cases, abused.

I see no reason why I should change my opinion and have failed to see anything in any of the letters so far published that in any way shows my statement to be wrong, as I stated in my letter in the August issue of "The Practical Engineer," in reply to Mr. Wakeman. I do not hesitate to say that I still condemn the use of the monkey wrench to close valves regardless of who advocates it, and I believe it to be absolutely wrong. Now, why is it that a valve is allowed to get in such a condition in any plant as to require such extra strain to get it steam and water tight?

Mr. Wakeman says it is right to use the wrench for extra leverage and says he uses the wrench to make his valves tight. Mr. Wakeman has quite a reputation as an engineer and has always received praise for the numerous articles which he has written and which have been read with much interest, and when he replied to my letter of the June issue, condemning me for claiming it was wrong to use anything in aiding to close a valve, or, in other words, to use a wrench for such a purpose, it caused much surprise. He has not given any good reason why I am wrong, for any engineer, having valves in his charge and knowing they are in such condition that he has to use a wrench to get them tight, ought to be the last person to claim that another man is wrong for condemning the use of the wrench on valves. Now, if his valves were in the condition they should be, they would not require any wrench. I cannot agree to the use of any such ancient and barbarous methods of operating valves.

I answered the July letter of his in the August issue and told him I would either repair or renew those valves if they were mine, as I have never used a wrench or had any boilers injured either. He has acknowledged that he has known of valves to have their stems twisted off by the use of the monkey wrench. The writer has seen just such cases, and this is one of the reasons why I so strongly condemn the use of the wrench, and feel I am fully qualified in the stand I take on this subject.

Mr. Wakeman says to use a wrench judiciously no harm can be done. Well, let us see what would be the result of using moderate force at the end of a wrench. For illustration, we will take a 3-inch valve, the wheel of which is 7 inches in diameter and the brass stem ⅞-inch in diameter, with four threads to the inch. The area under the joint of stem stock and exposed to the pressure is 13 square inches, and the stem pressure is 95 pounds, making 1235 pounds of strain on this joint before any more is put on to it by the wheel and wrench.

A 10-inch wrench put on this wheel with 25 pounds of force will give a strain of 7225, which, added to the 1235, will give 8460 pounds strain. Where I get the 25 pounds force from is where Mr. Wakeman says in closing a valve he puts about 25 pounds pressure on the valve, which makes it steam tight. I take it for granted he means the force exerted on the end of the wrench. It has been figured out that a man can easily, with both hands on a 7-inch wheel, put a strain of 1500 pounds under the stem stock and this, together with the 1235 pounds caused by the steam, gives a total of 2735 pounds of strain just with the hands. Now, why does anyone want to use a wrench when an ordinary man can put such strain on a 3-inch valve with his hands?

This ought to convince anyone that it is wrong to use the wrench, as I have claimed. Valve troubles, if not caused by faulty material, design or poor workmanship, are caused by abuse or lack of care.

In reply to D. S., on page 21 of "The Practical Engineer" for November, I would say that my theories have always worked all right, and with my system always expect them to, and that I never knew of any insurance company that would prevent anyone from making repairs that were necessary. So keep your valves in good condition and there will be no need of using a wrench to close them, as it is poor practice, to say the least.

No. Abington, Mass. A. T.

—o—

Opening and Closing Valves. Trouble is Often in Packing the Stem.

EDITOR THE PRACTICAL ENGINEER:

It isn't my desire to cut in on a line where I am apt to get scalded. However, I will take a chance, as anyone else in the business has to do. I do not wish to give the impression that I consider myself authority, but this matter of opening and closing valves is quite interesting and deserving of further comment. I have used the wrench on valves, as I believe all other engineers of any length of experience have done, but I can easily count the times, for when I have to use a wrench once to open or close a valve, I try to make it a point to remedy the valve and discontinue the use of the wrench.

There is one thing certain, that if a valve is in good condition, it is not necessary to use a wrench to close it tight and I believe that Mr. Wakeman knows this as well as anyone else does. I could see nothing in A. T.'s first article but good, straight, common sense, and I think Mr. Wakeman's criticism of that article was wholly uncalled-for.

In the July number, Mr. Wakeman says that he has an 8-inch valve. It is quite a coincidence, but the writer has an 8-inch valve also. It does not leak; I do not use a wrench to close it tight, nor flush in the face during the operation of closing or shutting it, or in closing or shutting any other valve I have.

A great many times, the trouble with valves is in the packing of the stem. I consider it just as necessary to have the stem of an important valve properly packed as the piston of an engine. I have observed that this is often neglected by engineers. I do not consider a valve stem properly packed unless it is steam tight and loose enough to work easily. I have seen valves which it was impossible to close with the hands because of escaping steam, and I have seen others where the packing was so tight and hard, that one could hardly turn the wheel. These conditions engineers often meet with in going from one plant to another and under these conditions, I say, use the most convenient means at hand in closing or opening the valves, if it is nothing more than a monkey wrench, but do not forget or neglect these valves.

At your first opportunity, take them apart, grind them in, or face them, or renew them if necessary, and do not neglect the stem. Clean it thoroughly, and, if it is worn, turn it up, if possible; if not, file and smooth it with emery cloth. Clean the nut and gland in good shape and use wedge packing, graphite and cylinder oil instead of candle wicking and asbestos, which is often used. If you have no wedge packing, make some. It does not have to be a perfect wedge. I keep on hand a supply of ⅜-inch round rubber core packing, which I use a great deal. I cut the ring the required size for the stem and split it lengthwise in such a manner as to form a wedge.

I have packed pistons in this way, using 1-inch packing, with stuffing boxes eight to ten inches long with very good results. It is not necessary to split every ring in packing a large piston or valve stem, but in all cases use plenty of graphite and cylinder oil.

Ashland, Wis. E. N. GINE.

Opening and Closing Valves. Engineers do Many Things they would not put in Books.

EDITOR THE PRACTICAL ENGINEER:

I have been quite interested in the discussion of "Opening and Closing Valves," and would like to say a few words in regard to it. I am a young man and have been in the business only about eleven years, but at present have charge of perhaps as large a plant as some of the engineers arguing on the subject.

In my experience, I have used a wrench on valves, sometimes when I was in a pretty tight place, sometimes with benefit and sometimes the reverse. When a valve is closed in the proper way and is not tight, the disc or seat is out of order or else some foreign substance has got into the valve, and putting on a wrench will make it harder to get tight next time.

There are many things an engineer does when driven to it that he would not put in a book of engineering were he writing one.

Mr. Wakeman says the argument was started by another than himself, but I don't agree with him. A. T. was writing his experiences and observations and giving his ideas regarding engineering practice when Mr. Wakeman wrote a rebuke to A. T.'s views on the matter, and because A. T. and others answered and took opposite ground to him, he comes out in the November issue and brings up his reputation as a good engineer and says he knows he is right. Others have a right to their opinion as well as he.

If any engineer can handle valves as Mr. Wakeman and other Connecticut engineers do and thereby save their employers expense, I should advise them by all means to do so. I frankly confess I haven't the ability to manipulate monkey wrenches on leaky valves with any such success.

Abington, Mass. A. Y. E.

Change in Piping to Allow for Expansion. Strain on Valves.

EDITOR THE PRACTICAL ENGINEER:

I have been very much interested in your "Letters from Engineers" and would like to give a few of my ideas on piping to boilers and engines. I send two diagrams showing how we have connected one of our boilers to the steam main and how it was originally connected. In Fig. 2 the flange on the main to which the 6-inch pipe is connected is on the top, but originally it was on the bottom of that section of the main, as shown in Fig. 1. As the main flanges have an even number of bolts they were easily turned over. It can be seen at a glance at Fig. 1 that with the flange on the bottom and the valve connected to that, there was little chance to allow for expansion in the pipe between boiler and main. The expansion of the pipe and boiler together brought quite a strain to bear on the connection, and the result was that the pipe connections

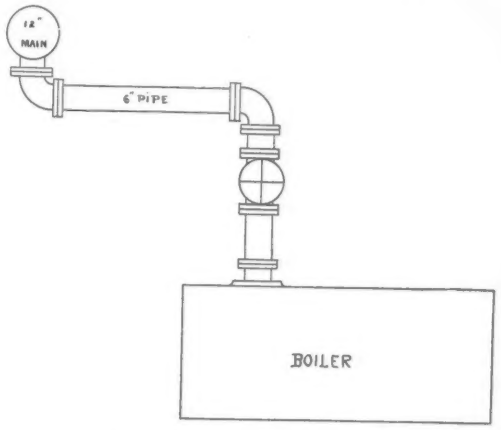


Fig. 1. System of Piping as it was connected.

were continually leaking, and it is a wonder that the ell was not fractured.

With the long bends, as it is now arranged in Fig. 2, there is a very good chance for expansion. I imagine some engineer will say the valve is put in the wrong place, but after much study I came to the conclusion that it was the only place for it. If it is placed either next to the boiler, or the main, when the boiler is cut in with the rest, there is a very good chance for water hammer. Some engineers favor a valve at each end, one next to the main and the other next to the boiler. In that case, one must be opened before a fire is started under the boiler, and there must be a drip valve above the other. With the ordinary boiler room attendants that would be rather unsafe, for, if one valve is not opened (preferably the one next to the boiler) before getting up steam, I fail to see how disastrous water hammer can be avoided. It has happened that under those conditions ells and angle valves have been blown to pieces, as some of you no doubt know. With the valve in the position shown in Fig. 2, water hammer is impossible. I believe in having intelligent attendants in the boiler room, and am glad to say that the majority of them with whom I

have had dealings have been such. At the same time, I think it is a good plan to have things so arranged that such mistakes cannot be made; in fact, have things arranged so that they will be like some of the machinery advertised nowadays—absolutely fool-proof.

It has always been a puzzle to me, in this plant of which I am writing, that so little regard was given to expansion in the boiler room, while in the engine room, where it is not needed half as much, liberal allowance was made for it. The steam main in the engine room is about twelve feet above the throttles, and an angle valve is connected to the top of the main and a long turn copper bend connects it to the throttle valves. While I don't favor the angle valves, it makes a very handy valve to pack, and repairs can be made on the throttle valve without disturbing any of the rest of the plant. The

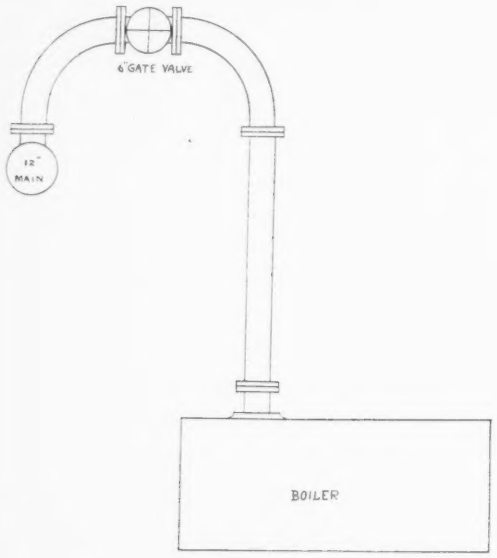


Fig. 2. System of Piping as now arranged.

objection I have to using an angle valve is the strain that is brought upon the body of it from expansion and contraction of the piping. The gate valve, of course, cannot be packed very well unless steam is shut off from both sides of it, and in a plant that runs continually it is hard to keep it packed.

I notice that one of your correspondents thinks that an angle valve should not have any pressure under the disc. Now, I can't quite agree with him. I think that he underrates the power of a screw. The threads on a properly constructed angle valve will withstand any strain that the steam pressure may put on it, and steam enough can be brought to bear on it that will ruin the disc without hurting the threads in the least. As far as wear is concerned I think it is negligible. In the plant where I am employed there are three throttle valves having square threads, one 4 inch, one 5 and one 6 inch, and they have been in use over twelve years and show no signs of wear.

We will assume that we have a 6-inch angle valve with a wheel whose radius is 6 inches, and is shut with a strain of 20 pounds, which is perhaps more than A. T. would allow and certainly is not more than Mr. Wakeman considers proper in certain cases. I don't think it would hurt the seat or disc myself, but I am trying to prove the strength of the threads. Using a well-known rule, which is:

Power $\times$ length of lever $\times 2 \times 3.1416 =$ weight $\times$ pitch. Let X = weight, then if the pitch of the threads is 4 per inch $20 \times 6 \times 2 \times 3.1416 = X \times \frac{1}{4}$, from which $X = 753.98 \div \frac{1}{4}$, or $X = 3015.92$.

We see that a power of 20 pounds on the wheel would put a pressure of 3015.92 pounds on the top of valve disc, which would not be straining any part. Then according to the conclusions arrived at by some engineers on the cylinder head bolt question, 100 pounds of steam would not add any strain to the disc as 100 pounds of steam would put only 2800 pounds on the bottom of valve.

I do not write this as a criticism, only as a friendly argument, and hope it will be received by all as such, and, as there are probably many flows in it, the readers of "The Practical Engineer" are at liberty to pick them out.

No. Abington, Mass. A YOUNG ENGINEER.

Rodney's Troubles.
Or Do We Need a License Law in Michigan?
(Fourteenth Letter.)

Its no use mr. editur fur u tu tel me that steem iz a flued ur a gas fur i no it ain't. i tride to lite the steem that wuz leekin out ov a rivut in my biler aftur u told me that, and henry wuz watchen me and he give me the laf. i allus thot my injine wuz a thrasher injine, but henry tells me that it iz a trackshun injine, and if he iz rite i am going tu tri and git a job whear i kan hav wurk all the yeer around. henry shode me a kard frum a fellar that iz a boss on the line with a nu trackshun kumpeny, and the feller told henry that they wud be runnin kars in less than a munth so i thot ide rite and ask u how mutch u wud charg fur the use ov my trackshun injine if u owned it, if thay wud want tu uze it fur the hull 24 hours ov the day and fur evri day in the weak. fur henry sez that thay eckspect tu karry a grate menny pasungers on the rode, so u wil du me a grate favur ef u wil tel me jist how tu charg fur the use ov mi trackshun injine az henry kalls it.

the uther day i had a lot ov bother with a essentrick. it jist slipt on thu shaft and the injine wud not go one way or thu uther i hed no trubble tu put it bak in its plase. i jist turned thu kam, as henry kalls it, around till thu burrs fittud intu there holes in thu shaft and thu injine runs jist az gud az it did the day aftur i brot it to orkners corners. then thayl tell u that u ott tu hav sum buk lernin az well az ecksperence with injines to maik a gud reliubble injernear. annuther thing i want tu ask u. az i wuz thrashen sum otes thu uther day a feller druv bi and holler'd tu me tu stop up the leek in mi stak saddel. now whear iz thear a saddel on a thrasher injine and biler. i no i is used on a hors but i nevur saw i on a biler. i hav a fu lodes ov ri straw that i wil giv u fur nothen if youl kum tu the villidge and draw it away. u must hav sum time tu ureself wonce in a while so kum up and we'll uze u rite

ecspectin tu heer frum u sune

i remane ures truley

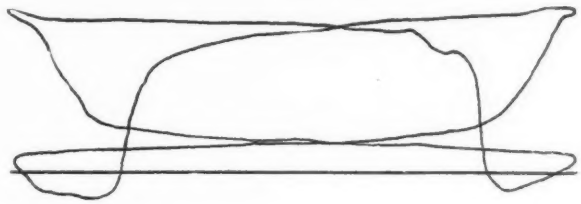
rodney gumkirk
orkners korners,
munrow kounty,
Mishegan

One Kind of Valve Expert.

EDITOR THE PRACTICAL ENGINEER:

Herewith please find a pair of cards taken from a throttling engine 12" x 16", running at 140 revolutions per minute, scale of indicator spring 40 pounds.

The engine is brand new and was set up and started by one of the builder's experts. Anyway, the expert set the valves, etc., on Sunday and the mill was to start up the next day. He was one of those fellows who knew it all and could tell by watching the valve rods and piston just how she was taking steam and cutting off. Well, he left Danbury on Sunday night, after leaving everything O. K., as he said, and he intended



Indicator Cards from Engine whose Valves were set by a so-called Expert.

leaving for Cuba in a few days to set up a couple of large engines.

The engine was started up on Monday at 7 A. M., and it was an impossibility to make steam enough to run her. They had to shut her down and apply the indicator and the first cards taken are the one I send you a tracing of. After setting over the valves by the indicator she was started and is running O. K. It goes to show just how expert some of the experts are.

Danbury, Conn. J. M.

Hints for Closing Down for the Night. Don't Forget!

EDITOR THE PRACTICAL ENGINEER:

In factories and buildings where no night engineer is employed, the engineer in charge should be very particular about the condition of things before leaving his engine room for the night.

In a certain building in New York City, the engineer on shutting down his plant for the night forgot to shut off his gauge-glass. During the night the glass burst and emptied the boiler of water. The boiler was not injured, as the fire was banked, but the machinery was severely injured. It was a manufactory of machine tools and the bright work on all those machines was rusted by the action of the steam that found its way through the different floors. All the belts that had cement joints were loosened, the shafting and hangers were rusted; in fact, so much damage was done that the plant had to be shut down for a week, throwing over 300 men out of work.

On another occasion, an engineer forgot to close the water valve on the feed-pump, also his feed-valve on the line that supplied the engine room with steam. The steam gauge indicated 45 pounds pressure. During the night the pressure fell, allowing the boiler, heating system and main steam pipe to fill with water. The next day, which happened to be Sunday, the engineer found things in a condition calculated to make him say things. The water had leaked through the throttle, cylinder and into the exhaust pipe, the drips of which happened to be opened, and as no provisions were made for carrying away the exhaust drips, with the exception of a small barrel that was sunk in the engine room floor and emptied by a syphon, the barrel had overflowed and the water had found its way into the wheel-pit. It took many hours of hard labor to put things into condition to enable the plant to be started on Monday morning, though the water fortunately had not reached the belt.

Some years ago, a book-binding concern decided to economize in operating expenses. They began by discharging the night engineer who had been in their employ for many years and who kept things in good condition. It was too expensive to pay a night engineer, so they hired an old man to act as watchman and raise steam for the day engineer. Everything went along nicely for awhile. One night, however, the gauge-glass burst. The old watchman, thinking the boiler had burst, ran to the nearest fire-alarm box and sent in an alarm for the fire department. By this time the steam had worked havoc among the books and printing machinery, which caused a serious loss to the printing concern.

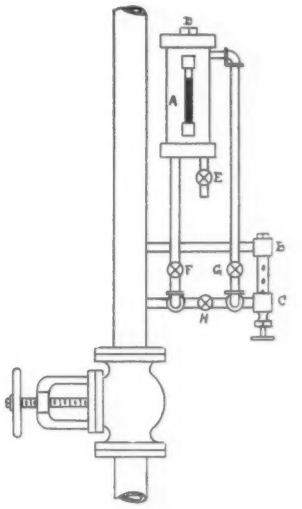
No doubt you will admit that there was no economy in discharging the night engineer, but it should be remembered that the day engineer forgot to shut off this gauge-glass.

Cincinnati, Ohio. A. M.

A Home-made Lubricator.

EDITOR THE PRACTICAL ENGINEER:

The importance of a good lubricator is of value especially if the unpleasant and annoying refilling can be lessened. I have just completed one that I am highly pleased with, as I am only required to refill it three times a week. There is also a saving of oil as there is always some lost in drawing off the water in the regular kind. One like that shown in the sketch can be made with little cost and labor and can be made any convenient size to suit conditions. A is a piece of 3-inch pipe, 10



Home-Made Lubricator.

inches long, with a cap screwed on both ends, which answers for the reservoir. B and C are fittings taken from an old lubricator. D is the filling plug and E is to draw the water off when A is empty of oil.

To refill, the valves F and G must be closed, but when in operation they are open and valve H is kept closed.

Brooklyn, N. Y. J. G. S.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Capacity of Water Pipes.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me a rule through your valuable paper for finding the capacity of a one-inch pipe, the pressure being 10 pounds per square inch?

(2). Is the capacity of a pipe directly proportional to the pressure?

Boston, Mass. A. C. J.

The general laws relating to the flow of water through pipes are not so exact as is the case with almost all the other branches of engineering, as there are so many factors entering into the calculations which cannot be accurately found or which are continually changing with each new condition.

The loss of head due to the resisting friction of the interior surface of the pipe is usually large, and in long pipes it becomes very great, so that the discharge is but a small percentage of that due to the head or pressure upon it. Many experiments have been made upon pipes of different sizes and lengths under different velocities of flow, and the discussion of these has enabled approximate laws to be deduced which govern the laws for practical use. These laws are as follows:

1. The loss in friction is proportional to the length of the pipe.
2. It increases nearly as the square of the velocity.
3. It decreases as the diameter of the pipe increases.
4. It increases with the roughness of the interior surface of the pipe.
5. It is independent of the pressure of the water.

Based upon experiments of the flow of water for different sizes of pipes, the following table has been compiled:

QUANTITY OF WATER FLOWING THROUGH CIRCULAR PIPES.

	Ratio of Head to Length of Pipe.						
Diam. Inches	1 to 10	1 to 20	1 to 40	1 to 60	1 to 80	1 in 100	1 in 200
	Quantity in Cubic Feet per Minute.						
½	.173	.122	.086	.071	.061	.054	.039
¾	.541	.382	.270	.221	.191	.171	.121
1	1.20	.849	.600	.491	.424	.379	.268
1½	3.62	2.62	1.81	1.48	1.28	1.09	.810
2	7.80	5.54	3.90	3.20	2.76	2.47	1.75
3	22.9	16.2	11.4	9.36	8.10	7.26	5.12
4	48.6	34.3	24.3	19.8	17.1	15.3	10.8
5	86.4	61.1	43.2	35.1	30.5	27.3	19.3
6	138	97.9	69.0	56.6	48.9	43.8	30.9
7	204	145	102	84.6	72.6	64.8	46.0
8	289	204	145	118.0	102.0	91.2	64.8

In the use of the table, three things must be known: the diameter of the pipe, the head in feet and the length of the pipe. In the above example, the diameter is given as one inch and the head is given as 10 pounds per square inch, which is equivalent to 23 feet head, as each pound per square inch is equivalent to 2.304 feet head. As the flow of water is directly proportional to the length of pipe, a value of 250 feet will be assumed. The ratio of head to length is then as 23 is to 250, or as 1 is to 10, about. Examining the table, it will be found that a one-inch pipe with a ratio of head to length of pipe, 1 to 10, will give a flow of 1.2 cubic feet per minute, which is equivalent to 75 pounds per minute, or 8.9 gallons. Any other conditions, such as different diameter of pipe, different length and different head, can be found in the same manner from the table.—[Ed.]

Horse Power of Boiler. Height of Chimney.

EDITOR THE PRACTICAL ENGINEER:

Kindly answer the following questions:

(1). I have two boilers 54 inches by 14 feet, with 46 3-inch tubes. What would be the horse power of each when running under good conditions?

(2). The stack to which these boilers are connected is 36 inches in diameter. I burn slack coal. What height should the stack be?

Seattle, Wash. J. B. F.

(1). The commercial horse power of a tubular boiler, 54 inches in diameter and 14 feet long, would be about 50 horse power.

(2). The height of the chimney should be between 75 and 100 feet.—[Ed.]

Will Cold Water Cause an Explosion?

EDITOR THE PRACTICAL ENGINEER:

An 150 horse power fire-tube boiler and a 200 horse power engine were running together and the engine commenced to pull water, and before it was stopped, it brought the water down from one gauge and a half to the level of the middle of the second row of flues. The fire was pulled out, with the steam about 90 pounds pressure. There was no way of getting water in the boiler, as we had only a common power pump which pumped water from the heater.

After two hours, the steam went down to 60 pounds and we filled the boiler up some with cold city water. Was there much danger from an explosion? The boiler was a new and high-priced one.

Bekke, Tenn. B. C. A.

The above state of affairs is certainly one that is not very desirable and while there may not have been so very much danger from an explosion, considering that it was a new boiler, there was a great danger of ruining it by burning or buckling the tubes or plates. In all cases of this kind, when the water in the boiler is low, a very good maxim is: "Do not get excited and don't do things in a hurry." Many men have regretted what they did in a moment of haste. It is natural, when the water is low, to first pull the fires. There are several objections to this. The first thing that happens when the fires are pulled is to stir up the hot bed of coal. This not only increases the heat in the fire box, which adds to the formation of steam in the boiler, but it is also very uncomfortable for

the fireman who is hauling the fire. In the face of such heat, it is almost impossible to work with the best thoughts. The fireman must either dump the flaming mass of coals immediately in front of the boiler, where he is exposed to the intense heat, or else it must be carried away.

A very much better plan would be to cover the fire with green coal or ashes, preferably coal. The layer of coal should be thick and generous so as to intercept as much of the radiant heat as possible and to prevent any amount of air from being drawn up through the grate. The fire doors should be opened and the ash-pit doors and damper closed. This method will not at first create a large amount of heat nor will it afterward subject the boiler surfaces to the exposure of very cold air.

When cold water is pumped into the boiler, it is always liable to more or less cause undue strains in the portion of the boiler where it is admitted, and it would be particularly undesirable to admit it when there is low water. A fall of 90 to 60 pounds pressure means only a fall in temperature of from 331 degrees to 307 degrees, so that the temeprature is not reduced very much inside the boiler. The temperature is, however, considerably reduced in the fire box or upon the heating surfaces, so that waiting two hours after pulling the fire, there was not much danger of an explosion by admitting the cold water.—[Ed.]

Exhaust from Gas Engine.

EDITOR THE PRACTICAL ENGINEER:

Would it be possible to condense the exhaust from a gas engine so as to produce an effect similar to that produced by condensing the exhaust from a steam engine? If not, why not?

Octonto, Wis. A. G. F.

It is impossible with the practical means at our command to condense the exhaust from a gas engine in the same manner that the exhaust from a steam engine is condensed. The principal reason that steam is condensed is due to the fact that when changed from steam to water, its volume is reduced 1200 times, so that an almost perfect vacuum is obtained, and the only thing an air pump is required to do, in a surface condenser, is to draw out the condensed water and the small amount of entrained vapor which hot water always gives off in a vacuum.

While a condenser would, of course, lower the temperature of the exhaust gases from a gas engine, it would be impossible to lower its temperature enough to change it into a liquid and while the temperature of the exhaust gases would be lowered, its effect upon the economy, by removing the atmospheric back pressure by the production of a vacuum, would be negligible.—[Ed.]

Starting Alternating Current Generators.

EDITOR THE PRACTICAL ENGINEER:

I have been a reader of your valuable magazine for a year and never a copy reaches me without bringing valuable information, and no enterprising engineer could afford to be without it. I have several little questions I would like to ask through your valuable columns.

(1). I was paying a visit to an electric street lighting plant some time ago where they have a 75 horse power engine belt connected to an alternating current generator. There is an exciter used and when the street lights and store lights are all on the circuit, the ammeter only shows 25 amperes and voltmeter 115 volts. How do you account for that?

(2). What would be the course of procedure in starting an alternating current machine? Do you have to switch in machine and exciter before you start or after?

Toronto, Can. F. C.

(1). It is probable that perhaps the ammeter and voltmeter were connected to the exciter which supplied the field current to the alternator, in which case the field strength of the alternator is recorded. If this was not the case, then if the ammeter was connected to the alternator circuit, it read the output of the generator. As the readings were 115 volts, 25 amperes, this would be sufficient to supply 50-16 candle power lamps or 100-8 candle power lamps. If there were more lamps on the circuit than this, then the ammeter either read incorrectly or else it read the output on perhaps some auxiliary circuit.

(2). The course of procedure in starting an alternating current generator is as follows: Start the generator with the field circuit open and after the machine has reached full speed, close the field switch with all the resistance in. Gradually throw out the resistance in the field until the generator has arrived at its proper voltage.

It is better to keep the field circuit open when starting, because you do not have to start against the drag which the field always brings on the armature, and it is very much better to close the field circuit with the resistance all in because you avoid any excessive voltage due to closing the field circuit suddenly, and besides, you avoid the possibility of any injury to the frame of the machine by its sudden attraction of the armature.

After the machine has attained its proper voltage, the machine can then be thrown in circuit. If it is to be run in parallel with other machines, it must attain synchronism before the main switch is closed.—[Ed.]

Horse Power of Engine. Lifting of Water in Boilers.

EDITOR THE PRACTICAL ENGINEER:

I am going to bother you with another question. What is the horse power of the following engine: Cylinder 12" x 12"; speed 240 revolutions per minute; steam pressure 100 pounds; point of cut-off ¾ stroke? It is equipped with a throttling governor. How much difference would it make if it ran 270 revolutions per minute?

(2). The engine raises the water in boiler when it is running at 270 revolutions per minute, what is the cause?

Clyde River, Nova Scotia. R. S.

(1). As we have stated before, it is impossible to calculate exactly what horse power an engine is giving out without having an indicator card, because from an indicator card, the mean effective pressure on the piston is accurately obtained. If calculated otherwise, certain assumptions have to be made. In this case we will assume that 90 pounds pressure is acting on the piston for three-fourths of the stroke when cut-off takes place. Assuming 2 pounds back pressure, this will give a mean effective pressure on the piston of about 82 pounds. Using the well-known horse power formula, this will give 134 horse power. When the revolutions are increased to 270 revolutions, when the engine is running under the other same conditions, it will give out 152 horse power. If the steam was throttled so that the mean effective pressure was reduced to 60 pounds,

then the horse power when running under 240 revolutions would be 98, and when running under 270 revolutions, it would give out 111 horse power.

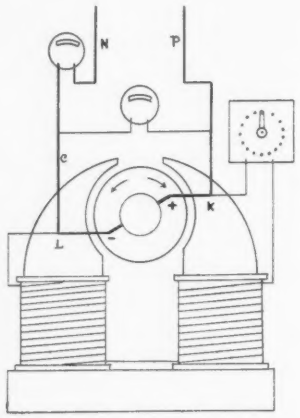
(2). The principal reason why the engine raises water in the boiler is because the engine uses more steam than the boiler can comfortably produce. It must be remembered that the engine must have its cylinder filled to three-fourths of its capacity 540 times every minute. If the boiler is not capable of doing this, the tendency is that the boiler will prime and lift water. Under these conditions, if the separator on the line can not take care of all the water, the engine will certainly be damaged.—[Ed.]

Motors and Generators.

EDITOR THE PRACTICAL ENGINEER:

Please answer the following questions on electricity:

(1). I have read in electrical books that in the accompanying diagram the current flows from K out to the positive line wire P and thus to the distributing circuit. From L the main current passes through wire *c*, to and through an instrument called the ammeter.



Connections for a Shunt Dynamo.

The point I cannot understand is, how can a current be sent to the line through wire P and another current sent out over wire N? I may be wrong, but if the generator sends out a current through wire P, it returns through wire N, and if I am right, will the top of the generator turn to the right or left, as shown by the arrows?

(2). If a generator drops its load and voltage, the other generator, running in parallel with it, turns it as a motor. Will it run in the opposite direction, or in the same direction?

Cambridge, Mass. D. W. A.

(1). Current can only flow in one direction in a direct current circuit. That is, if the main current passes out of the positive line wire and thus to the distributing circuit, it must return through the other wire back to the negative brush of the dynamo, and so on through the armature and out again at the positive brush. Current cannot be sent out over the line P and the line N at the same time.

With the current flowing out of the line P and back along the line N, and as you have shown the connections of the dynamo to be of the shunt type, the direction of rotation would be in the direction of the arrow pointing to the right.

(2). In reference to this question, it will depend upon the type of machine as to whether it will run in the same or in an opposite direction when one generator drops its load and voltage and the other generator runs it. A series machine, which, however, is very seldom used, will reverse its direction of rotation when run as a motor. A shunt machine does not reverse its direction of rotation, and it is for this reason that generators are wound in this manner, it making no difference whether it supplies the line with current or whether the line supplies it with current. With a compound machine, the result is naturally the resultant of the two windings, and the direction of rotation is the same or reversed, depending upon whether the shunt or series field is the strongest.—[Ed.]

Is the Boiler Large Enough to do the Heating?

EDITOR THE PRACTICAL ENGINEER:

I wish you would kindly figure this out for me:

On the first floor of a building I have two 25-inch high radiators with 3 and 4 columns each, one 32-inch with 3 columns, one 21-inch with 2 columns, one 34-inch with 2 columns and one 10-inch with 2 columns.

On the second floor, I have one 11-inch radiator with one column, two radiators 38-inches high with two columns, one 28-inches high with two columns, one 20-inches high with four columns, one 17-inches high with two columns, one 9-inches high with two columns, one 24-inches high with one column and one 24-inches high with 3 columns and four 1¼″ pipes, 16 feet long.

On the third floor, I have two 34-inch high radiators with 2 columns each, one 18-inch with two columns, eight 38-inch with 2 columns each, one 16-inch with two columns, one 11-inch with 2 columns, one 17-inch with 2 columns and three 1¼″ pipes, 12 feet long.

On the fourth floor, I have two 32-inch radiators with 2 columns each, one 28-inch with 2 columns, one 12-inch with 2 columns, one 11-inch with one column, two 38-inch with two columns each, one 20-inch with 2 columns, one 24-inch with 2 columns, one 30-inch with one column, one 36-inch with one column and two 12-inch with 3 columns each and three 1¼″ pipes, 35 feet long.

In the basement, I have 720 slabs for indirect heating and in the annex 114 slabs, each slab containing 10 square feet of heating surface.

To do this heating we have two 54″ x 14 feet return tubular boilers with a six-inch drum on the head end for the main building and a four-inch on the back end to supply the annex. Now, what I wish to know is, how much heating surface is in the boilers and how much is in the radiators to see if I have a sufficient supply in the boilers? I do know one thing, it is hard work to keep up steam on a cold day.

Boston, Mass. F. H. R.

The first step necessary in the solution of this problem is to find the number of square feet of radiating surface which the boiler must supply. If the number of square feet in the radiators is multiplied by 270, the number of heat units given out per hour by an ordinary heating surface, this will give the number of heat units required per hour, and if this product is divided by 966, the latent heat in one pound of steam, the result will give the number of pounds of steam required per hour.

As the horse power of a boiler is the equivalent evaporation

of 34.5 pounds of water from and at 212 degrees in one hour, if the number of pounds of steam obtained by the above calculation is divided by 34.5, the horse power necessary to heat the buildings is obtained.

To proceed with the calculations: It is found from a catalogue of steam radiators that there is 42.5 square feet of heating surface on the first floor, 81 square feet on the second, 131.5 square feet on the third and 127 square feet on the fourth, making a total of 382 square feet available of direct heating. This heating surface will give out $382 \times 270 = 103{,}140$ heat units per hour and divided by $966 = 107$ pounds of steam required per hour.

In the basement and annex, there are 834 slabs having 10 square feet each, or a total heating surface of 8340 square feet. Each square foot of surface used in indirect heating will give out 490 heat units per hour, which makes a total of 4,086,600 heat units required per hour, and dividing by 966, it is found that 4230 pounds of water will be required to do the indirect heating, or a total of 4337 pounds for the whole plant. Dividing this by 34.5, the number of pounds of water required to be evaporated by the boiler per horse power, gives 125 horse power required to do the heating.

A 54-inch by 14-foot boiler is capable of giving out about 50 horse power, so that with the two boilers you only have 100 horse power available to do 125 horse power of heating.—[Ed.]

Amount of Pump Suction.

If a pump were made perfect, it would draw water from a depth of 34 feet, but in practice this cannot be done. If the pump is in first-class condition, it might lift 25 feet, but it is much better practically to limit the lift to 15 feet, as the shorter the lift the better the pumping effect. For warm water, the lift should be done away with entirely and the hot water be allowed to flow into the pump. Centrifugal pumps will lift up to 20 feet, but about 7 or 8 feet will be found a much better lift. In general, it may be stated that the faster the speed of the pump, the less should be the length of the suction.

Mufflers on Gas Engines.

The method of muffling the sound of the exhaust of a gas engine is to lead the exhaust pipe to a cast iron chamber of considerable capacity set near the engine. A separate connection leads from the reservoir to the outside of the building. A second muffler pot will still further deaden the sound of the exhaust.

Feeding Cold Water.

The practice of feeding cold water into a boiler cannot be too strongly condemned, as boilers fed in this manner invariably leak at the seams near where the water is delivered and show other unmistakable signs of weakness. If the use of cold water is unavoidable, a "circulating" feed pipe should always be used. This is a pipe entering horizontally through the front head and made to travel a few inches below the water level the entire length of the boiler and nearly the whole width and is finally delivered downward in the coolest part of the water. By this means it is heated nearly to the temperature of the water in the boiler before it can come into contact with any part of the shell, and so the evils of violent contraction are obviated.

Improved Steam Engine Indicator Cylinder.

Improvements in steam engine indicators, and designs intending to increase the scope of usefulness, and to reduce to the minimum the errors of this instrument, seem to have received a considerable attention from the principal manufacturers during the past year, with the result that several new features have been produced.

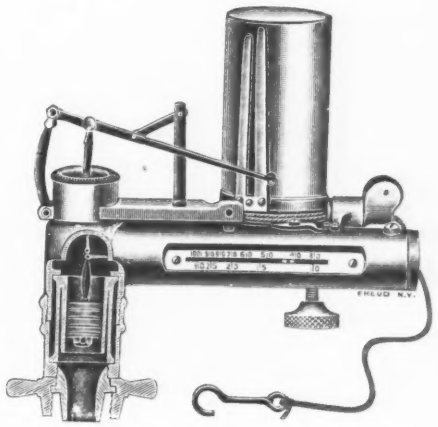


Fig. 1. Bachelder Adjustable Spring Indicator.

The following illustrations and description are devoted to a new product of Messrs. John S. Bushnell & Co., 136 Liberty Street, New York, N. Y., and consists of a cylinder both steam and air jacketed, and also so arranged that cylinders of various metals and areas can be readily interchanged. It is claimed by the manufacturers that with this device, friction between the piston and cylinder caused by the expansion of the metals is

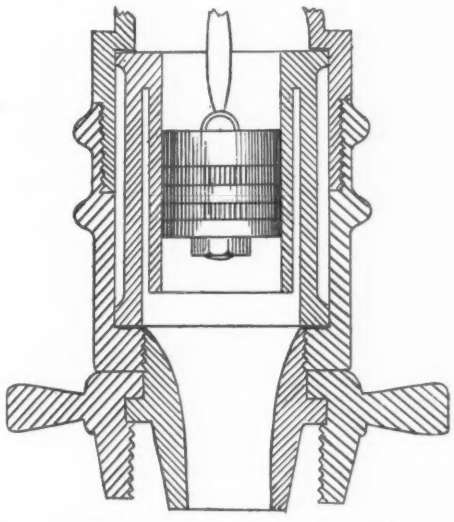


Fig 2. Sectional View of Cylinder, Piston and Outside Case.

absolutely eliminated, regardless of the temperature given out by either high pressure or superheated steam, and that therefore a close-fitting piston can be successfully used under all conditions. The convenience with which the cylinder can be removed and replaced with another is also worthy of note. Fig. 1 shows the Indicator complete, with broken section illustrating the position of the cylinder as in use. Fig. 2 shows an enlarged broken section view of the cylinder, piston and out-

side case of the Indicator clearly defining the steam and air jackets.

The cylinder is faced at each end true with the flanges of the upper and lower sections of the case, so that when these sections are screwed together, an air-tight joint is made at both the top and bottom of the cylinder. These sections of the case are held from unscrewing by a set screw. The cylinder can be removed by turning the set screw back one turn and then unscrewing the case.

Further information can be obtained from the manufacturers as mentioned above. An illustrated circular giving full and complete description in detail, together with prices, etc., will be sent free upon request.

The Buckeye Automatic Boiler Cleaner.

The accompanying illustration, Fig. 1, represents the Buckeye Automatic Boiler Cleaner, manufactured by the Buckeye Boiler Skimmer Co., Toledo, Ohio. This device is intended to remove impurities from the water in the boiler and discharge them into a precipitator or settling chamber and to return pure water to the boiler. The skimmer is adapted to all types of boilers and prevents to a great extent the formation of scale and deposits upon the heating surface of the boiler. Any old scale, which has been formed, will be freed by the pure water, as the formation of new scale will be prevented and the

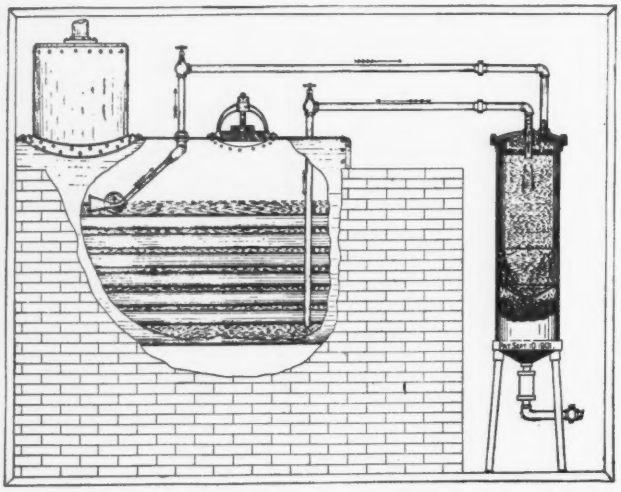


Fig. 1. Buckeye Boiler Cleaner.

old scale will become rotten and loosened by the expansion and contraction of the boiler and tubes.

It is well known that the accumulation of scale and sediment in a boiler not only increases the amount of fuel required in a given time, but it also tends to shorten the life of the boiler by the gradual overheating and consequent weakening of the plates due to the absence of that close contact of the water with the plates, which should always be had for the proper transference of heat.

One of the principal advantages of this kind of mechanical cleaner is that the cleaning is continuous, the impurities which rise to the surface being constantly removed as long as the boiler is in operation. A considerable variation of the water level will not affect the efficiency of the skimmer because it is fitted with a flexible joint which allows it to rise and fall with the changing water level.

The skimmer, shown in Fig. 2, is a wide mouth funnel suspended by a tubular arm through which the impurities pass from the surface of the water on their way to the precipitator or settling chamber, which is located at any convenient point outside the boiler setting. The floats attached to the skimmer keep it always submerged at the same depth irrespective of the height of water in the boiler, which keeps the funnel at the point where the greatest amount of "scum" will be collected.

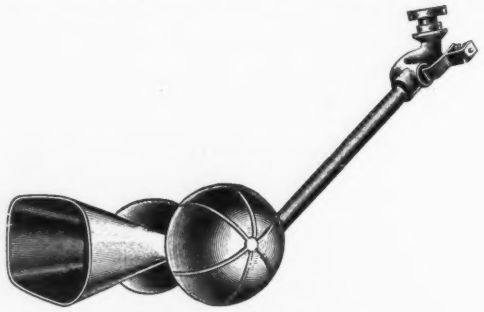


Fig. 2. Skimmer for Cleaner.

The floats are non-collapsible, tested to 500 pounds pressure and are made of metal to which sediment will not adhere.

The regrinding flexible joint shown in Fig. 3 makes the floating skimmer possible. The ground joint has a taper which prevents it from sticking, but if for any reason it should ever leak, it may readily be reground to a perfect seat.

The arrows in Fig. 1 indicate the direction of the water in the pipes. The floating impurities are collected by the wide-mouthed funnel and pass through the tubular arm and flexible joint to the outside piping, through which it is conducted to the precipitator. The incoming water passes through the

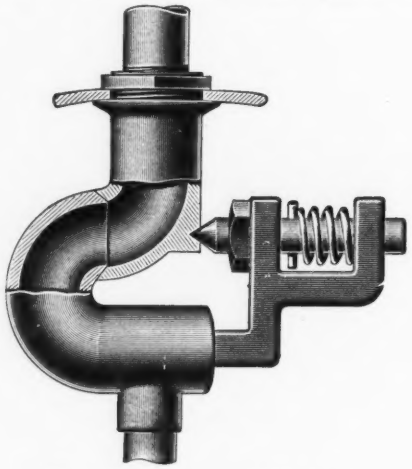


Fig. 3. Regrinding Flexible Joint.

perforations and downward between the inner tube and main shell of the precipitator until it reaches the lower end of the tube, when it changes its direction of flow to an upward course, while the sediment separates from it and settles in the chamber below. The clear water then returns to the boiler relieved of its impurities and only slightly cooler than when it started.

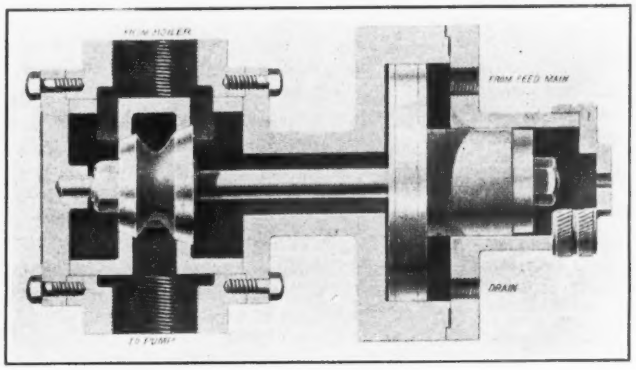
The sediment may be blown out as often as necessary, depending upon the amount of impurities in the feed water and therefore must be determined by experiment in each case. Since the working of the mechanical cleaner is continuous, the

longer the boiler is run without cooling, the better it is for the boiler, thus avoiding frequent shut downs for cleaning.

The Mullin Automatic Controller for Feed Pumps.

This controller is inserted into the steam pipe of the feed pump below the throttle, and a connection is made at the right, as indicated on the engraving, to the feed water main. The steam pressure acting upon the full area of the piston tends to open the valve and make the pump run faster. The water pressure acting upon the other side of the piston tends to force the valve toward its seat and slow the pump down. As the area of the piston on the water side is less than that upon the steam side, the pressure per square inch in the feed main must exceed that of the steam before the valve commences to close, and the required excess pressure for boiler feeding is thus attained without springs, weights or other mechanism than the simple differential piston.

So long as the boiler pressure remains constant the pressure



Mullin's Automatic Controller.

in the feed main will remain at a point in excess of that pressure determined by the difference in area of the two sides of the piston, and this no matter what the difference in rate of feed may be. There need be no running back and forth between the feed valves and the pump to adapt the speed of the latter to varying demands, and the uniform pressure in the feed main enables the water tender to preserve a uniform water line with much less handling of the feed valves. Should the boiler pressure increase, the pressure in the feed main, being relative thereto, will increase also; but as it increases proportionally, the difference or excess will be greater, and with the same setting of the feed valves more water will be fed at a time when it is most desirable. On the other hand, with a falling steam pressure the excess will be diminished and the feed will be lessened, helping the boiler to recover its pressure. The device is almost as simple externally as a pipe fitting, is self-contained, has no stuffing boxes or external moving parts, and is made up with ground joints. The valve and seat are of phosphor bronze and the piston metallic packed, with means of taking up wear. The large area exposed makes it sensitive to small changes in pressure. They are made in pipe sizes from ½ inch up by the Federal Valve Company, 2534 Western Avenue, Seattle, Wash.

Book Review.

Dry Batteries.—A practical book with 30 original illustrations. Spon & Chamberlain, 123 Liberty Street, New York. Price, 25 cents.

This is a practical handbook on the designing, filling and finishing of dry batteries, with tables, for automobile, gas engine, medical and coil work, electric bells, alarms, telephones, experiments and all purposes requiring a dry battery. It is clearly illustrated throughout from original drawings made by Norman H. Schneider, another of "Care and Handling of Electric Plants," which show clearly not only the steps necessary in the manufacture of such a battery, but the connections of the batteries for various purposes.

The book is written with great clearness and should appeal to anyone interested in the subject.

Camden Council.

IN MEMORY OF IRWIN S. YOUNG.

Camden Council has sustained a serious bereavement in the death of Irwin S. Young, who has for many years been an active worker in the affairs of the Council and has contributed largely to its success.

The following resolutions were presented by a committee composed of H. R. Taliferro, Chas. Pfeiffer and Joseph Whitley and were adopted at a recent meeting of the Council:

WHEREAS, The Almighty God in His wise dispensation has removed from this earthly life our beloved brother, Irwin S. Young. As the Almighty God doeth all things well, we know that our loss is his eternal gain and if we are faithful here on earth we will meet in that great Council above.

RESOLVED, That in the death of our brother, the community has lost a worthy citizen and the Council a faithful adherent. While we mourn the loss of our departed brother, we recognize in his removal the hand of the Almighty God, before whose august will we as upright members reverently bow.

RESOLVED, That our heartfelt sympathy and sincere condolence are extended to his bereaved family in the loss of a husband and that a copy of these resolutions be spread on the minutes and a copy be sent to the bereaved family and to "The Practical Engineer."

COMMITTEE.

Stag Dinner at Providence.

Rhode Island, No. 5, N. A. S. E., celebrated their seventh anniversary with a stag dinner, given at "The Wellington," on Thursday evening, October 20th, and the affair was a magnificent success in every way. There were about 175 members and guests present, and in addition to Gov. Garvin, Mayor Miller, Lieut. Gov. Utter and President Freeman of the Board of Aldermen, the guests of honor included President John E. Kendrick of the Common Council, George A. Littlefield, Esq., and several prominent officers of the N. A. S. E. from Boston and other points. The anniversary committee in charge of the affair consisted of D. W. Johnson, Chairman; H. H. Hopkins, Secretary; A. L. Griswold, Robert L. Blanding, James Casey, Benjamin C. Potter, John Hickey, Thomas Harvey and Fred Liebrick.

New Corresponding Engineer.

Supreme Chief Engineer H. M. Trout has appointed Past Grand Chief Frederick Markoe, of Municipal Council, No. 20, Philadelphia, to the position of Supreme Corresponding Engineer of the A. O. S. E. to fill the place of J. M. Stallings, of Baltimore, who has resigned.

Mr. Markoe is a most excellent choice for this important office, which he will administer with the same fidelity and earnestness that has been given to every office that he has held.

TRADE NOTES

The growth of the graphite industry, the theory of graphite lubrication, the special advantages of flake graphite in contrast to amorphous graphite and the practical relation of graphite to the theory of lubrication are all well told and generously illustrated in "Graphite Lubricants" a handsome booklet issued by Joseph Dixon Crucible Co., Jersey City, N. J. for distribution among engineers.—Send for one.

"There's as much diff rence in pumps as there is in women," said an engineer of varied experiences the other day. He was speaking of a "Lackawanna." He continued, "Why that pump is just like my first wife, never kicks about anything, but there are others; pumps and women, too, you bet." If any reader of the "P. E." wants to know more abut this remarkable docile pump he can procure a copy of the new catalog just issued by the manufacturers. Lackawanna Pump Works, Walnut street and Caporese avenue, Scranton, Pa.

The steel mixture boiler door arches built by McLeod & Henry, Troy, N. Y., are not only an excellent protection to the furnace doors and boiler fronts, but will quickly save their small cost in added efficiency. Every engineer who isinterested in genuine economy should write for catalog and prices.

If you happen to be interested in blow-off valves and what engineer isn't, it will pay you to write to the A. W. Cadman Mfg. Co., 2824 Smallman street, Pittsburg, Pa., for a catalog describing Cadman's Indestructible Blow-off Valve.

The Shepherd Engine Co., Franklin, Pa. have recently booked a considerable number of orders for Shepherd engines, among which are two small units for Brandon Hall, Boston, Mass. Three engines for Columbus Savings & Trust Co., Clumbus, Ohio, and two for the Northwestern Ohio Bottle Co., Toledo, Ohio.

The Shepherd engine is a highly developed example of high speed automatic type, combining great strength and rigidity, with simplicity of design in the minimum of space for power generated. The inventor has succeeded in combining many points tending to greater efficiency and economy in operating.

Catalog upon request.

Brotherhood overalls are good overalls. They are called "Brotherhood" because they are made by a brotherhood man who applies genuine brotherhood principles to all that he does. The work rooms in his factory show it; the employes show it, and the quality and fit of Brotherhood overalls proves it. H. S. Peters began with a coal shovel, he has always been a union man and a staunch advocate of union principles. He believes that good pay and pleasant conditions are productive of best results, that's why his factories at Dover, N. J., are always busy and that's why Brotherhood overalls are good. Most dealers keep them, but if yours don't, just write to Peters'.

A handsome large catalog illustrating and comprehensively describing the Vigilant Feed Water Regulator for steam boilers has been issued by the Chaplin-Fulton M'f'g. Co., 32 Penn Ave., Pittsburg, Pa. A copy will be mailed free to any engineer or steam user upon request.

The Smith Clamp, judging from the ever increasing demand for it, is reported by the manufacturers, appears to be gaining in popularity with engineers. Its utility and effectiveness as a leak stopper seems to be a settled matter, and engineers throughout the country are showing their appreciation by increased orders.

W. Clifford Smith, 138 N. Sixth street, Philadelphia, the manufacturer, will send an illustrated circular and price list together with a combination pocket mirror and pin cushion to any engineer free.

M. D. Van Buren, M. E. of the Holland Co. Chicago, writes us that their sales of Larkin Metallic Packing are increasing unprecedentedly.

For many years past Mr. A. C. Lippincott has been closely identified with the invention, manufacturing, and operation of steam engine indicators.

During all these years he has been flooded with correspondence in which information has been sought upon this important subject. This pressing demand suggested to him the advisability of placing his indicator knowledge before stationary engineers in the form of a Correspondence Course of Instruction, which plan he has carried out in a most thorough manner, as the instruction papers cover the subject even to the most minute details.

Realizing that many engineers are unable to afford a large expenditure he has gone still further and offers to each student an indicator without any additional charge.

Mr. Lippincott will answer any further questions concerning his work if addressed in care of Indicator Instruction Co., Newark, N. J.

"Gladiator" Asbestos Metallic High Pressure Packing Rings is a new high pressure packing ring that is actually moulded to shape in steel dies under hydraulic pressure, which makes it almost as solid as though it were made of metal, and still it remains entirely flexible.

These rings are made by the New Jersey Asbestos Co., of Camden, N. J., and, being composed of the same material as their celebrated "Gladiator" Asbestos Metallic Packing which is so well known to engineers throughout the country, the impossibility of their burning out is readily recognized. Made in all sizes varying from one-sixteenth inch. Rings of any special size will be made to order.

Any one interested in these rings and desiring samples can secure the same by writing to the Home Office of this firm at Camden, N. J.

The Standard Gauge Mfg. Co. of Syracuse, N. Y., are issuing a catalog which is not only very artistic, but exceedingly valuable. It contains an illustrated list of the different types of pressure and vacuum gauges for various purposes; marine clocks, engine registers, counters, speed indicators, steam engine indicator, gauge testing pumps, pop safety valves, water gauges, gauge cocks, air cocks, oil and grease cups, thermometers,etc.

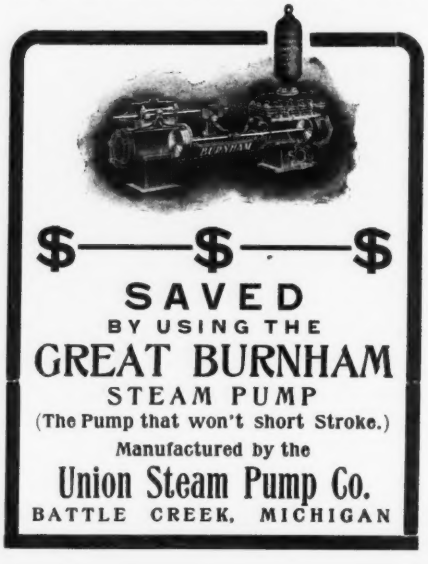
One of these catalogs will be sent free upon request to any reader of "The Practical Engineer."

Every pound of water that is condensed means a loss of at least 966 heat units which is valuable work lost. These heat units are being lost constantly from uncovered steam pipes, both in winter and in summer, but especially in winter.

The Norristown Covering Co. have been at work night and day making pipe coverings to prevent the loss of these heat units. The saving is so great as to pay for the cost of the covering in a short time. They not only manufacture Asbestos Magnesia moulded coverings for high pressures, but weather-proof coverings, vim coverings for low pressures, felt coverings for heating work, cold water pipe coverings, asbestos cements, mineral wool, etc. etc.

Write to them for prices and catalog; they will interest you.

The advantages of the Corliss valve are known to every engineer, so that the Linstrom Corliss Valve Steam Trap embodies not only all the advantages peculiar to this type of valve but it has a number of other mechanical points that should appeal to every one. The trap does not require packing of any kind; no pins or screws are used in connecting the mechanism, three-fourths of the port opening is avail-



able in case of emergency and should anything unforseen happen, an automatic alarm whistle will notify the operator that something is wrong.

For the present, the manufacturer, John T. Linstrom of Allentown, Pa., will give with every steam trap order, a blue print showing how to set valves on Corliss engines of the simple and compound types with one or two eccentrics. As the winter is on and the condensation in steam pipes is large, now is the time to get traps. Mr. Linstrom has just issued a new catalog which will be mailed to any reader of "The Practical Engineer" upon request.

The American Water Softener Co. of Philadelphia, has been compelled, by their constantly increasing business, to move into more commodious offices and combine the laboratory with the general sales department. They now occupy a large suite of offices in the Mutual Life Building, 1011 Chestnut St., Philadelphia.

Many of our readers will be glad to learn that the railway steamship and mill supply business carried on for a quarter of a century by the late H. A. Rogers, at 19 John St., New York, will be continued at the old stand by the H. A. Rogers Company.

We bespeak for the new concern the same liberal patronage that the painstaking efforts and conscientious fullfilment of obligations which characterized the transactions of the late Mr. Rogers secured for him, and which he so fully merited.

The Ruggles Improved Flue Cleaner is described and its numerous points of merit are comprehensively shown in a neat little circular and price list issued by A. W. Gunther & Co., 470 Jefferson St., Milwaukee, Wis. The Ruggles is said to be a most excellent scraper; one of its great advantages being that it will adjust itself to any variations in diameter of the same flue.

TO WHOM IT MAY CONCERN: Our attention has been called to an article which has appeared in some journals regarding the injury to boiler tubes by the use of a certain type of tube cleaner. In order to correct any wrong impression on the subject, we wish to explain that we do not use in any of the cleaners which we manufacture, a blow of any kind in removing the scale, nor is steam used in driving them. The work is all done by means of cutter wheels and a circular motion is given to these wheels which act upon the scale in a steady manner, grinding it away from the iron, without doing any injury whatever, either by expanding or loosening the tubes. This, we are prepared to guarantee in the strongest manner.

Our machines have been in practical successful use for years in some of the largest plants in this and foreign countries, and this fact alone, we think, is sufficient testimony as to their unequalled merit. While the article in question does not in any way refer to such machines as we are building, but to another type altogether we thought this simple statement on our part would avoid any wrong impression on the subject, and would explain the situation as far as our own machines are concerned.

THE LAGONDA MFG. CO.

Every engineer who desires to test Keystone grease for lubrication should write at once for a large sample can, and a Keystone brass cup, both of which will be sent, express prepaid to any address, free of all cost. Address Keystone Lubricating Co., 20th & Allegheny Ave., Philadelphia.

A blotter pad, composed of the finest grade of rag blotting paper, with celluloid back handsomely lithographed in colors, is being sent out by H. B. Underwood & Co., 1025 Hamilton St., Philadelphia. A request will bring you one.

JUST WHAT YOU NEED,

A New Book on Injectors. Their Construction Care and Management, 84 Pages, 45 Engravings, 16 Tables, By Frederick Keppy, M. E. I will send you a copy of this valuable Book on receipt of 25 cents in postage stamps.

F. KEPPY

108 Park Street, Bridgeport, Conn.

NO SPRAY
NO DRIPPING ROOFS
NO DAMAGED WALLS

Caused by the water and oil from the Exhaust pipe, if The Burt Exhaust Head is used.

Send your order to-day. We send The Burt Exhaust Head anywhere on approval.

The Western Automatic Machine Screw Co., Elyria, Ohio, says:—"We are pleased to report the three Burt Exhaust Heads at our plant are giving satisfaction."

THE BURT MFG. CO.

Largest Manufacturers of Oil Filters in the world.

204 Main St., Akron, Ohio, U. S. A.

Also supplied by Oil Companies, Engine Builders, Dealers, and Power Contractors.

FAIRBANKS CO.
Sole Agents for Philadelphia.

ANY good hand pump readily delivers Dixon's Flake Graphite, mixed with oil, to a valve, no elaborate devices or expensive changes are necessary.

The application of Graphite is as simple as its effect is marvelous.

To know Dixon's Graphite is to swear by it.

Send for Booklet 96—C. and learn all Dixon's Flake Graphite can do for YOU.

JOSEPH DIXON CRUCIBLE CO.
Jersey City, N. J.

Cochrane Heaters

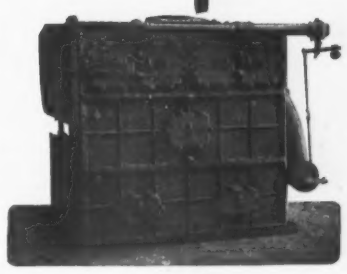
The kind of feed water heater that you ought to put in is a "thunderin'" important matter. The chances are that the time required for you to investigate our Cochranes will bring you greater returns than the time you are certain to give to the selection of your boiler or engine.

Less than 10 per cent. of all the heat in the steam entering a non-condensing engine is accounted for in the work done, radiation, etc. The heater deals with 15 per cent. of all the heat in the steam.

Many heaters require 16 per cent. more steam and 16 per cent. more water than do Cochranes.

Some heaters give no purification whatever. The Cochrane Heaters will give you all you are entitled to under the conditions.

And so it goes—but what we are after is your inquiry for particulars. We want the opportunity of presenting the facts to the man who is ready, or getting ready to buy.



HARRISON SAFETY BOILER WORKS

3144 N. 17th Street, PHILADELPHIA, PA.

Manufacturers of Cochrane Feed Water Heaters, Cochrane Steam and oil Separators and the Sorge-Cochrane Systems.

Alphabetical Index to Advertisers

American Injector Co..... 57
American School of Correspondence. 59
American Water Softener Co..... 44
Atlas Engine Works..... 62
Audel, Theo., & Co..... 48
Baum, The Separator & Machine Co., 54
Borgner, Cyrus 45
Buckeye Boiler Skimmer Co., The.. 37
Burt, The, Mfg. Co..... 31
Cadman Co., A. W..... 55
Cancos Manufacturing Co..... 46
Carr, E. M..... 49
Carr, Joseph 40
Chaplin-Fulton Mfg. Co..... 38
Cherry Chemical Company, The.... 47
Continental Chemical Co..... 56
Cook's, Adam, Sons..... 36
Crane, The, Co.....34 and 40
Crawford, A. 34
Davis, I. B., & Son..... 53
Davidson, M. T..... 62
Dearborn Drug & Chemical Works.. 1
Detroit Lubricator Co..... 33
Direct Separator Co..... 55
Dixon, Joseph, Crucible Co..... 31
Fearon, E., & Co..... 43
Federal Valve Co..... 47
Foster Engineering Co..... 45
France Packing Co..... 42
Frick Company 62
Garlock Packing Co..... 50
Gem Manufacturing Co..... 36
General Engineering Co..... 43
Gould Packing Co..... 45
Greenwald Co., Henry..... 33
Guenther & Co., A. W..... 36
Haines, William S., Co..... 48
Harrison Safety Boiler Works..... 31
Homestead Valve Mfg. Co..... 33
Huyette, Paul B.....34 and 56
Indicator Instruction Co..... 53
Jenkins Bros. .....Cover
Kelly, Benj. F., & Son..... 55
Keystone Elevator Inspection and Repair Co. 62
Keystone Lubricating Co..... 63
Keppy, F. 31
Kieley & Mueller..... 34
Knox Co. 44
Knox, Frank H..... 42
Kruger, The, & Blind Co..... 43
Kutztown, The, Foundry & Machine Co. 56
Lackawanna Pump Works..... 62
Lagonda, Mfg. Co., The..... 37
Lake Erie Boiler Compound Co..... 58
Liberty Manufacturing Co..... 36
Lindstrom, John T. .....31 and 49
Livezey, John R.....Cover
Lonergan, J. E., & Co..... 49
Lord, The Geo. W., Co..... 51
Lukenheimer, The, Company.....Cover
Main Belting Co..... 44
McCrea, James, & Co.....40 and 49
McLeod & Henry Company..... 57
McNelley, J. C..... 44
Milligan, William .....40 and 39
New Jersey Asbestos Co..... 44
Nonpareil Cork Mfg. Co.....Cover
Norristown Covering Co..... 64
Ohio, The, Injector Co..... 47
Olds Gasoline Engine Works..... 57
Patterson, Frank L., & Co..... 52
Patterson Manufacturing Co..... 58
Peerless, The, Rubber Mfg. Co..... 2
Penberthy Injector Co..... 56
Pennsylvania Electrical & Railway Supply Co. 46
Pennsylvania Rubber Co..... 49
Peters, H. S..... 44
Powell, The Wm. Powell Co..... 45
Pulver, Peter, & Sons..... 34
Quaker City Rubber Co..... 33
Rainear, C. J., & Co..... 45
Rich, J. & G..... 43
Reilly & Fearon Co..... 41
Robertson, Jas. L., & Sons..... 43
Rogers Co., H. A..... 36
Ruwell, W. F..... 43
Shiller & Co. 41
Simonds, Frank A..... 55
Smith, W. Clifford..... 47
Smith, Kline & French Co..... 42
Spon & Chamberlain..... 47
Standard, The, Gasket Co..... 46
Stephenson Mfg. Co..... 40
Sterling Pipe and Blower Co..... 35
Stillman G. G. 39
The Practical Engineer..... 56
Thompson, Richard, & Co..... 33
Tulley, Henry C., & Co...Second Cover
Underwood, H. B., & Co.....60 and 61
Union, The, Steam Pump Co..... 30
United States Metallic Packing Co., The 35
United States Mineral Wool Co..... 46
Universal Belt and Pulley Regulator Co. 39
Wakeman, W. H..... 46
Walsh Packing Co..... 40
Warley & Co., Thos. C..... 32
Warren Webster & Company..... 53
Whitlock, The, Coil Pipe Co..... 53
Williams Gauge Co..... 35
Watson & McDaniel Co..... 34
Watt's, John M., Sons..... 47
Wilson, H. B., & Co..... 47
Wright Manufacturing Co..... 48
Zurn, O. F., Co..... 45

WHY ARE

Warley's Boiler Cleansing Compounds

IMPORTANT TO

ENGINEERS AND STEAM USERS?

BECAUSE

WE DON'T WANT ONE DOLLAR OF YOUR MONEY

until we are able to convince you that these Compounds will positively prevent pitting and corrosion and remove and prevent scale or incrustation in your steam boilers, without injury to the metal of the boilers or any of the joints or fittings. Also that these goods do not contain anything of a poisonous nature, and will not pass over with the steam, nor injure any goods that you manufacture, not even food or drink products.

We make a specialty of the hardest and most difficult cases of scaly boilers, and use none but the purest and highest grade of Chemicals in the manufacture of our Compounds. An absolute guarantee given on each package to every new customer.

No. 221 South Front Street **THOS. C. WARLEY & CO.** PHILADELPHIA, PA.

MANUFACTURERS

Call or write us for book, "Practical Questions and Answers," to prepare for Engineer's License, which is free for the asking.

There Must Be Some Reason

WHY

Homestead Valves

are demanded in all four quarters of the globe

We will impart the secret to you. They are higher priced and very much better than the ordinary kind for all *HARD-TO-FILL* places.

Write for Booklet No. 10, just issued.

Homestead Valve Mfg. Co.

Box 1754, Pittsburg, Pa., U. S. A.

Works at Homestead, Pa.

Engineers and Firemen

A well selected crew of men with city references for soberity and experience are now registered with us for positions.

For prompt and satisfactory results, phone the

MECHANICAL DEPARTMENT

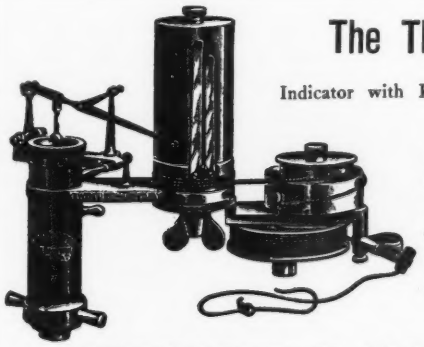
HENRY GREENEWALD COMPANY

250 South 11th Street, Philadelphia, Pa.

No advance. No registeration fees. We charge for results ONLY that proves the character of this exchange.

BOTH PHONES, (Direct Lines)

The Thompson

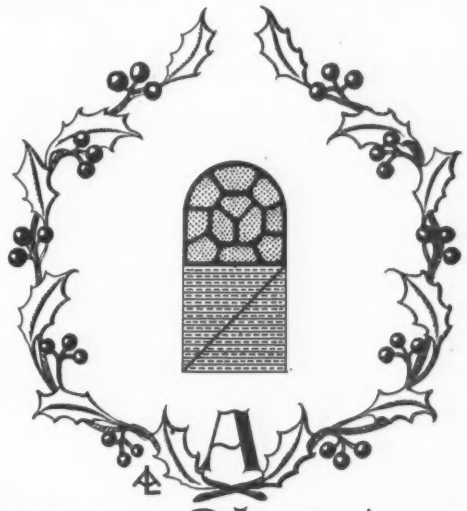


Indicator with Reducing Wheel. We also make Damper Regulators, Tube Cleaners, Shaking, Dumping and Stationary Grate Bars.

Send for Catalog.

RICHARD THOMPSON & CO., Sole Manufacturers

128 LIBERTY STREET NEW YORK, N.Y.



Merry Christmas

is what we are all looking forward to at this time of the year. Are you free to spend the day as you wish, or must you give up a part of it to repacking the stuffing box? Those who

USE P. P. P.

will enjoy a Christmas unmarred by the disagreeable job of repacking. No other packing lasts like P. P. P. If you don't use P. P. P. at present, profit by this years experience, and be able to enjoy all your holidays next year.

Quaker City Rubber Co.

Philadelphia

Chicago

The Quaker City Rubber Co. Philadelphia.

Gentlemen: Please send me your booklet proving that P. P. P. will save work.

Name _____

_____

St. and No. _____

City _____ *State* _____

Occupation _____

Employed by _____

Practical Engineer

Hughes
Smoke and Spark Preventer
For Stationary Boilers

Patented March, 1902, in United States and Foreign Countries

Prevents smoke and sparks, whatever kind of coal is used.

Insures perfect combustion, consuming all gases, thereby securing highest economy possible.

Increases the capacity of any boiler, while saving labor and fuel.

Can be readily installed in all forms of boilers and boiler settings.

NO MOVING MECHANISM NO STEAM USED NO POWER USED

NO EXPERIMENT, it being in actual successful commercial use.

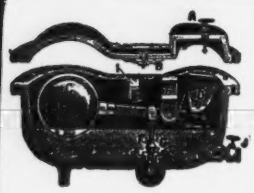
SIMPLE, therefore lower in cost than any other device for similar service.

SENSIBLE, therefore its method of operation is apparent to every one.

ECONOMICAL, therefore worthy of earnest consideration by prudent men.

WRITE FOR TESTIMONIALS

Address, 503 North Sixth Street
PHILADELPHIA



McDaniel Steam Traps

Always have a Water Seal over the valve and never blow steam; neither do they back up water

REDUCING VALVES
EXHAUST PIPE HEADS,
EJECTORS, RELIEF VALVES,
GREASE EXTRACTORS,
STEAM SEPARATORS, etc.

Watson & McDaniel Co.

MANUFACTURERS

Send for 1902 Catalogue

147 N. Seventh Street

For sale by the Jobbing Trade

CRANE VALVES
ESTABLISHED 1855

Steam Coal a Specialty

Telephone Connection 2-23-66

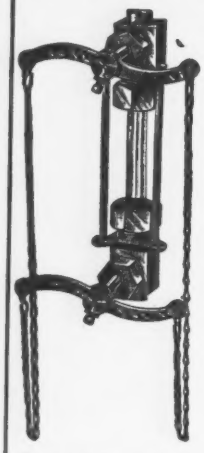
A. CRAWFORD COAL
1829-1833 N. Tenth St., Philadelphia, Pa.

PATENTS

promptly obtained OR NO FEE. Trade-Marks, Caveats, Copyrights and Labels registered. TWENTY YEARS' PRACTICE. Highest references. Send model, sketch or photo. for free report on patentability. All business confidential. HAND-BOOK FREE. Explains everything. Tells How to Obtain and Sell Patents, What Inventions Will Pay, How to Get a Partner, explains best mechanical movements, and contains 300 other subjects of importance to inventors. *Address,*

H. B. WILLSON & CO. Patent Attorneys
785 F Street, N. W., WASHINGTON, D. C.

SAVED



BY A
PULL
The "P. B. H."
Quick-Closing
Water
Gauge

A Pull on the Chain Does It.
Strongly Made.
Low in Price.
Sent on Approval.
Satisfaction Guaranteed.
We also make the
"P. B. H."
IMPROVED
GAUGE COCK

PAUL B. HUYETTE
1245 BETZ BUILDING
PHILADELPHIA, PA.

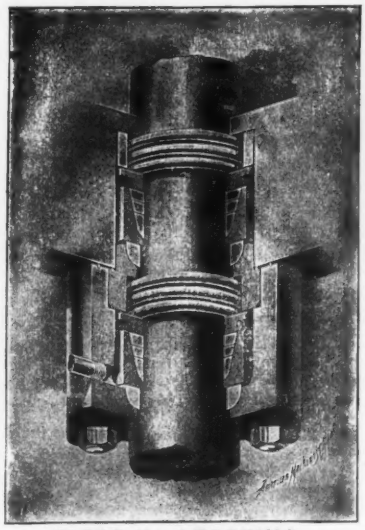
Kieley's Cantilever Expansion Steam Trap

Discharges against pressure—operates in any position; will not become air-bound; never freezes: simple in construction; durable, light, and easily adjusted. Guaranteed under any and all conditions. **Send for Catalog**

Tell us about it and the many superior points of other up-to-date steam appliances we make

KIELEY & MUELLER
34 West 13th St., - New York

JAMES J. ROGAN
810 Race St., Philadelphia



CLASS No. 1 PACKING

UNITED STATES
Piston Rod and Valve Stem
PACKINGS

Do their work well.
Their use will save you considerable money and endless trouble.
We can present convincing proof of their worth.

SEND FOR CATALOGUE AND PRICES

The United States Metallic Packing Co.

MAIN OFFICE AND WORKS:

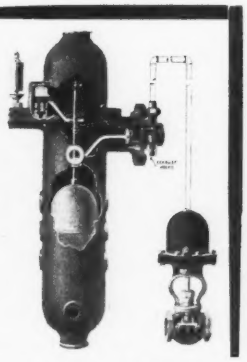
509 Great Northern Building
GHICAGO. ILLS.

No. 427 North Thirteenth Street.
PHILADELPHIA. PA.

1,000,000 H. P. EQUIPPED

WILL PAY ITS FIRST COST EVERY SIX MONTHS

GUARANTEED ONE YEAR



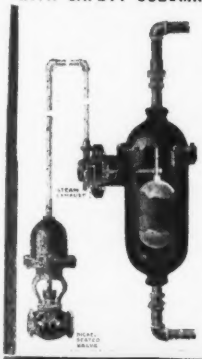
A FEW REASONS

DRY STEAM
LESS FUEL
LESS LABOR
FEWER REPAIRS

THE ONLY SAFETY FEED WATER REGULATOR ON THE MARKET

IS FOOL PROOF

OUR AUXILLARY REGULATOR USED WITH SAFETY COLUMNS



We Make Other Interesting Specialties

Ask for Catalog

THE WILLIAMS GAUGE CO.

FOURTH AVE. and TRY ST.
PITTSBURG, PA.

Exhaust Steam Condensation

from exhaust pipes is a nuisance, an expense, and an eye-sore.

THE STERLING EXHAUST HEAD

will clear the atmosphere of the water and grease, your mind from annoyance, your walls and roofs from rotting, and your future from the possibility of a law suit from a slippery side-walk.

SENT ON TRIAL, FREIGHT PREPAID

STERLING PIPE AND BLOWER CO.
HARTFORD, CONN.

Engineers Know

the many good qualities of the celebrated

MONCRIEFF SCOTCH GAUGE GLASSES

WE ARE SOLE IMPORTERS AND DISTRIBUTERS

LOOK FOR THE BLUE WRAPPER

TRADE MARK

Machine Tools and Wood Working Machinery
Engineers and Contractors Supplies, and Equipment

Send Specifications and write for Prices

H. A. Rogers Co.
19 JOHN STREET NEW YORK

RUGGLES IMPROVED FLUE CLEANER

The best Device on the market to-day for the cleaning of Smoke Flues.

This Device is so constructed that it adjusts itself to variations in diameter of Tubes, thoroughly cleans all spots, does not catch on its withdrawal, and effectually overrides all uneven surfaces. This Cleaner will not loose its temper by using it in hot Tubes and is just as efficient for hot or cold Tubes.

Write for booklet. Liberal discount to the Trade.

Sole Manufacturers A. W. GUNTHER & CO. Milwaukee, U.S.A.
Philadelphia Agents:—SCHADE & MARSHALL, 142 N. Sixth St.

There is only ONE

ALBANY GREASE

and we are the only makers

LUBRICATES EVERYTHING

Adapted to all kinds of machinery

Cost of using oil

Cost of using Albany Grease

Remember, a sample can of Albany Grease with an Albany Grease Cup free of charge or expense for testing.

The only information necessary to send is, pipe connection in bearing, depth of oil hole from top of cap to journal, and give particular part of machinery on which the same is to be tested.

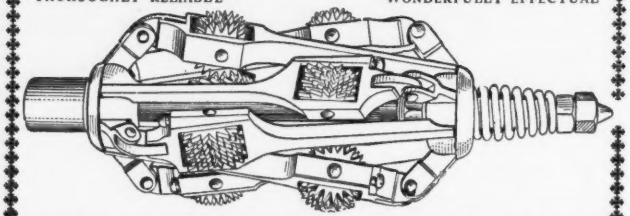
ADAM COOK'S SONS
313 West St., N. Y. City

THIS TRADE MARK ON EVERY PACKAGE.
Sold by Engineers and Mill Supply Dealers the World over.

THE KNOX WATER TUBE CLEANER

MOST SATISFACTORY THOROUGHLY RELIABLE

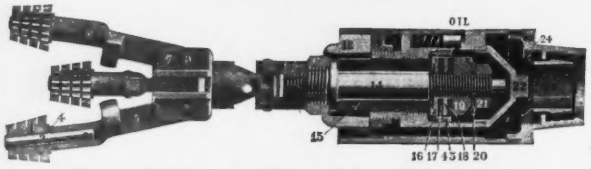
MOST CONVENIENT WONDERFULLY EFFECTUAL



Has revolving steel cutters working diagonally on anti-friction bearings. Work well in straight or bent tubes. No special fitting necessary.—Write

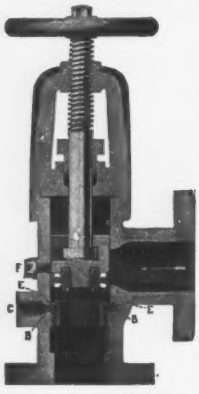
THE KNOX CO., Reading, Pa., U. S. A.

Liberty Manufacturing Co.
PITTSBURGH, PA.



The "Liberty" Turbine Cleaner

for cleaning water tube boilers are the most efficient, require less repairs and last longer than those of any other make. One "Liberty" Machine has cleaned all the boilers in a large Pittsburg Factory for the last three years, representing a total of **248 boilers**, each boiler having **108 tubes 18 feet long**, a total of **26,748 tubes, or 91 and one-tenth miles** of 4 inch boiler tubes, in which the scale was one-eighth to one-half inch in thickness.



The tube cleaners manufactured by the Liberty Manufacturing Co., are a success. They do the **work**; they **cut out boiler repairs**; they **cut down the coal pile.**

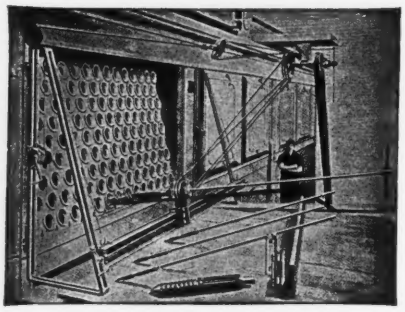
We make the "**Liberty**", "**Chicago**" and "**Niagara types.**

The "Faber" Blow-off Valve

"washes its face." Just before the valve seats a steam jet blows away all sediment from the seat and disc. **This steam jet does the trick and stops all usual blow-off valve troubles**

WRITE FOR CATALOGUE C.

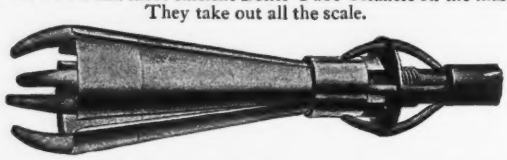
LIBERTY MANUFACTURING CO.
6907 Susquehanna Street - Pittsburg, Pa.



The Union Boiler Tube Cleaners

POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.



The Gem Flue Scraper

does the same for Smoke Flue Boilers

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

Write for Catalogue and Prices.

Gem Manufacturing Co.
Spruce near 33d Street - Pittsburg, Pa.

WEINLAND INSTRUMENTS
For "Boiler Surgery"

The worst cases of scale can be operated upon successfully with

Weinland Tube Cleaners.

Water drives the machine and a steady grinding process cuts the scale from the iron without expanding, loosening or injuring tubes in any way.

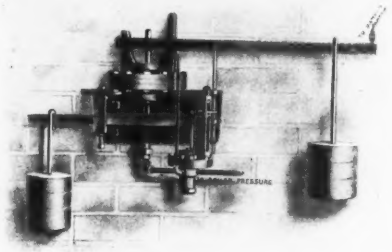
They have restored thousands of boilers to perfect condition, and what they have done for others they'll do for you. This cut shows our No. 8—THE KING OF TURBINE CLEANERS, besides which we manufacture others—Hand Cleaners and Power Driven Cleaners—all kinds and sizes for all styles of boilers and all sizes of tubes. "No Tube Cleaner Like a WEINLAND"—Anybody who's used one will tell you that.

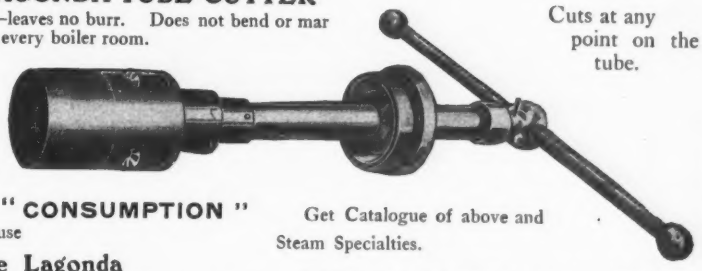
We do contract cleaning, if you want it that way.

For "AMPUTATING" Tubes use THE LAGONDA TUBE CUTTER

It does the work quickly, easily, and cuts clean everytime—leaves no burr. Does not bend or mar the tube in any way. A simple, inexpensive tool needed in every boiler room.

Cuts at any point on the tube.





For "CONSUMPTION" of Coal, use

The Lagonda Damper Regulator

It absolutely controls damper in stack on the slightest variation of steam.

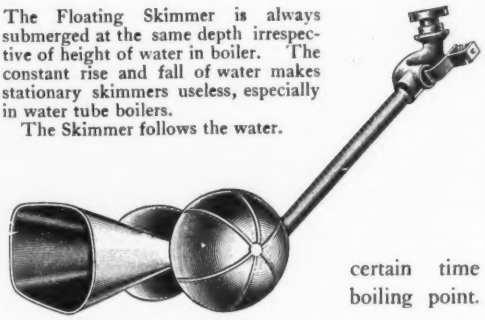
Get Catalogue of above and Steam Specialties.

THE LAGONDA MFG. CO.,
Springfield, Ohio.
Boiler Cleaning Experts—at it 20 Years.

EXPERT

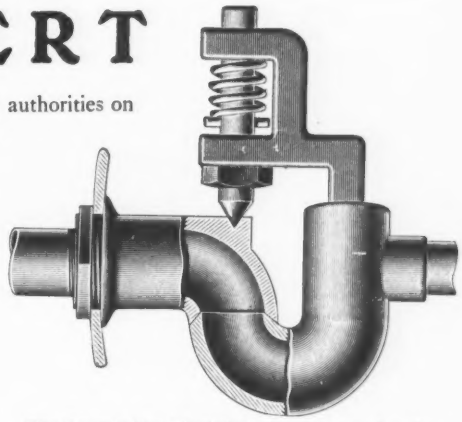
The Floating Skimmer is always submerged at the same depth irrespective of height of water in boiler. The constant rise and fall of water makes stationary skimmers useless, especially in water tube boilers.

The Skimmer follows the water.



The Floating Skimmer

Chemists and the leading authorities on steam boilers say that all the scale forming matter, and other impurities, come to the top of the water at a certain time after it reaches the boiling point.



The Re-grinding Flexible Joint which makes the Floating Skimmer possible

THE BUCKEYE AUTOMATIC BOILER CLEANER

collects it as fast as it comes to the top, and carries it away. It removes old scale and prevents new. No chemicals or no hammer and chisel needed. The Buckeye works whenever the boiler works, and costs nothing to maintain it after it is installed.

Study the Floating Skimmer and the Flexible Joint without which no Automatic Skimmer can do its work properly. Our fullest guarantee goes with every machine.

We install them on trial. **Send for Catalogue.**

The Buckeye Boiler Skimmer Co.
TOLEDO, OHIO

EASY MONEY

ENGINEERS can make a little easy money on the side by procuring subscriptions for the "Practical Engineer." We pay liberal commissions.

Salesmen for engineer's supplies and power plant equipment can make lots of easy money and at the same time will enlarge their acquaintance among engineers by soliciting subscriptions for "The Practical Engineer."

Its easy money, because all you have to do is to show an engineer a sample copy and he immediately owes you fifty cents—because he wants it.

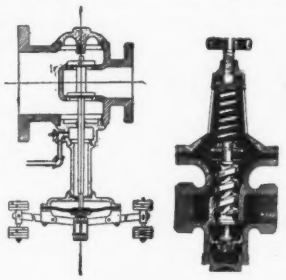
Hustlers who want to travel constantly can make good steady incomes. We have several young men who have done nothing else for years and who make from $25.00 to $40.00 a week. But to do this you must be a hustler.

When writing for our proposition tell us what you are doing now and whether you want to devote all or a portion of your time to the work.

ADDRESS CIRCULATION DEPARTMENT

THE PRACTICAL ENGINEER
46 North Twelfth Street, Philadelphia

WILLIAM MILLIGAN 'Phones: Bell-Walnut 1271a Keystone-Main 1-71 726 Sansom Street, Phila., Pa.



Manufacturers' Agents for Philadelphia, representing the

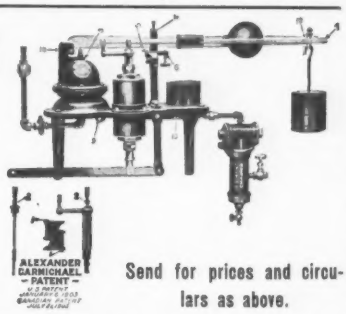
Watts Regulator Co.

Manufacturers of Steam Appliances, Steam Regulators, Water Regulators and Pump Regulators, Steam Traps, Boiler Oil Feeders Reducing Wheels.

SOLE AGENT for Pennsylvania and Southern New Jersey and Delaware for the

STILLMAN-CARMICHAEL IMPROVED DAMPER REGULATOR

(10 IMPROVEMENTS)



Send for prices and circulars as above.

YOU CAN'T LOSE--

Our plan is so simple and fair and square that you can't lose.

Universal Belt & Pulley Reg. Co.
New York

Brooklyn, Mar. 15, 1904.

GENTLEMEN:—The covering which you put on our pulleys at our factory, 28 & 30 Rodney Street, Brooklyn, has proved eminently satisfactory. Prior to its being put on one of the motors which drove the line shafting had to be set at an angle in order to keep the belt on the pulley. Since the application of your covering the motor has been squared up and is running perfectly straight.

We take great pleasure in recommending the covering.

Yours truly,
WATERBURY & CO.—Per Geo. W. Nock.

THE UNIVERSAL BELT AND PULLEY REGULATOR

is sold on a thirty day trial. Can anything be fairer than that? **It is guaranteed to last five years. Pulleys re-covered free of charge if worn off before end of time stated.** For either iron or wooden pulleys. It's to prevent slipping too. Send us the size of the pulley you wish to cover and we will give price of work complete.

235 Lexington Avenue, Universal Belt and Pulley Regulator Co. NEW YORK CITY

TWO GOOD BOOKS, FREE

Algebra Self-Taught

By W. P. HIGGS

This is a most excellent book that commences at the very beginning and goes step by step from one stage to another. It is simply written and easily understood.

Every young engineer should have one of these books. The study of Algebra is intensly interesting and a knowledge of it is a valuable possession.

Ammonia Refrigeration

A practical handbook for engineers in charge of ice plants. It is fully illustrated and contains numerous tables. The tables alone are worth the price of the book for reference purposes. It is fully indexed so that any detail may be found at a glance. It is in plain and comprehensive language and is printed in large clear type.

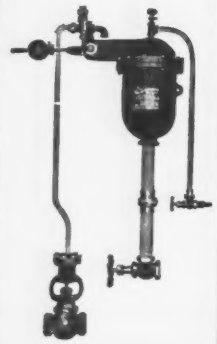
Either of the above books will be given free for a Club of Three Annual Subscriptions to The Practical Engineer at Fifty Cents Each, or both of them for Six Subscriptions.

One copy of either book and One Year Subscription for One Dollar.

This is an exceptional opportunity, and every engineer should take advantage of it while the books last.

THE PRACTICAL ENGINEER

46 NORTH TWELFTH STREET PHILADELPHIA, PA.



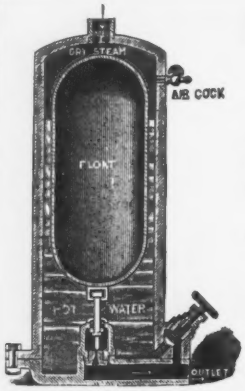
INSTALL THE

Vigilant Water Feed Regulator

THEY WILL PREVENT A DOSE OF WATER IN YOUR ENGINE CYLINDERS.

Let us send you a list of users that you may investigate. Write

CHAPLIN FULTON MFG. CO.
32 PENN. AVE. PITTSBURG, PA.



Remember :—

This is STEAM TRAP season.

If that old trap is wasting steam and not doing its work, replace it with the H. H. STEAM TRAP, and have no more trouble or expense.

We guarantee it to give satisfaction or pay freight both ways.

SEND FOR OUR CATALOG.

JAMES McCREA & CO.
Manufactures
67 W. Washington St., CHICAGO

STEPHENSON BAR BELT DRESSING
KEEPS BELTS SOFT AND PLIABLE

"Caught with the Goods"

(THE WRONG GOODS)

once But never again

Aug. 26/04. St. L. Mo.

Stephenson Mfg. Co
Gentlemen:- Please send me 30 Bars Belt Dressing, the same as those bought from you Mar 21/1902, I have been using other dressing since then but find your belt dressing the best.

Yours truly
L Petersen per AB.

LAURITZ PETERSEN,
Sash, Doors and Blinds,
S. E. Cor LYON & LYNCH STS.
ST. LOUIS, MO.
2800 Lyon Str. St. Louis Mo.

Write us for free sample.

Stephenson Mfg. Co.
ALBANY, N. Y.

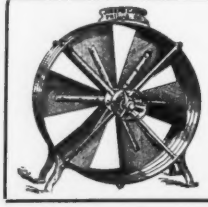
Practical Ammonia Refrigeration

By REDWOOD

A practical American handbook for engineers and helpers in charge of ice plants. Illustrated, cloth. **By mail, $1.00,** or will be sent free as premium for a club of three subscribers to The Practical Engineer, at 50 cts. each, address

THE PRACTICAL ENGINEER

46 N. Twelfth St. Philadelphia



CIRCULATING AND EXHAUST FANS FOR VENTILATING PURPOSES

also Light Pulleys and Hangers for Shafting.

Prices on Application. Send for Circular.

JOSEPH CARR, Manufacturer
132 N. Seventh St. Philadelphia

CRANE FITTINGS

ESTABLISHED 1855

Walsh Metal Face Packing

A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

PACKING FOR ELEVATORS a Specialty

Walsh Packing Co.

1118 and 1120 S. Seventh St., Philadelphia, Pa.

Walsh Combination Gaskets

WILL NOT BLOW OUT

Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets.

W. F. RUWELL

Late with H. B. Underwood & Co.

General Repairs to Corliss, Greene and other Steam Engines.

Cylinders and Valve Seats Rebored in Place

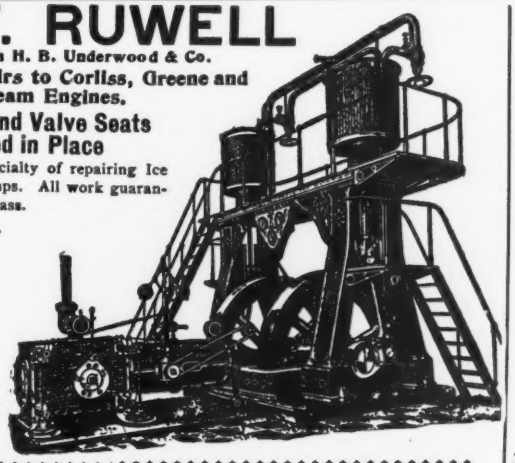
We make a specialty of repairing Ice Machines and Pumps. All work guaranteed strictly first class.

Office and Works.

719-721
NOBLE STREET
PHILADELPHIA

Tele. Connection

We make a specialty of Metallic Packing for Piston Rods.



Telephone **EAGLE IRON WORKS** Established 1851

Reilly & Fearon Co.

Successors to Hoff & Fontaine

MANUFACTURERS OF

Engines, Boilers, Stacks and Tanks

General Machinists' and Iron Founders

1152-1164 NORTH THIRD STREET, PHILADELPHIA, PA.

Complete Power Plants Steam Fitting Cylinders Bored in Position

General Repairs to Ice Machinery, Engines, Boilers, Pumps, Etc.

BOTH 'PHONES

E. FEARON & CO.

Engineers and Machinists

110 OXFORD STREET

PHILADELPHIA

Engines, Pumps, Boilers and Electrical Machinery
Textile, Dyeing, Chemical and Paint Machinery

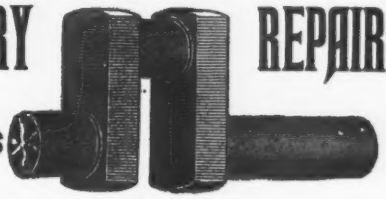
REPAIRING AND JOBBING PROMPTLY ATTENDED TO

James Gemmell Phones—Bell 42-69 D, Keystone 44-65 D

CYLINDERS OF ENGINES AND PUMPS REBORED IN PLACE

MACHINERY REPAIRS

STACKS, TANKS



General Engineering Co.

Engineers, Boiler Makers, Blacksmiths

J. Gemmell, Supt. Phila., Pa. 764 Swanson St.

F. W. SCHILLER W. G. RICE JOS. F. SCHILLER

SCHILLER & CO., LTD.

MACHINISTS AND ENGINEERS

Special attention given to repairing all makes of

STEAM ENGINES & PUMPS.

Cylinders Rebored in position by special machinery. Dynamo Commutators and Crank Shaft Journals turned off without removal.

Makers of Special Self-Adjusting Cylinder Packing.

Estimates Given Cheerfully, All Work Guaranteed

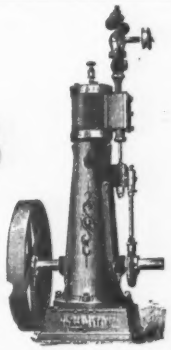
N. W. Cor. 5th and Locust Sts., Philadelphia, Pa.

ESTABLISHED 1871

J. & G. RICH

General Machinists

ENGINE BUILDERS
AND DEALERS IN MACHINERY



Especial Attention Given to Repairing and Erecting Steam Engines, Pumps and other Machinery, Shafting, Hangers, Pulleys, Etc.

120 NORTH SIXTH STREET, PHILADELPHIA, PA.
TELEPHONE

Steam and Gas Engine Repairing

We send Portable Tools and Expert Machinists' to **REBORE** Cylinders, Valves, Ports, Straight and Taper Crank Pin Holes etc., Reface Flat Valves, Turn off Crank Pins.

NEW PISTONS, ALL STYLES, STEAM SPECIALTIES

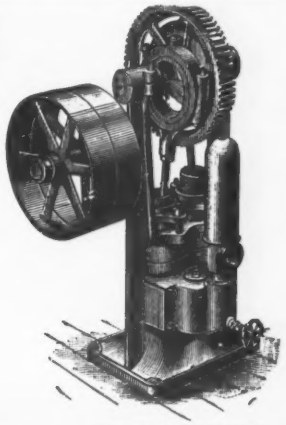
Emergency Repairs, Day or Night

ESTIMATES FURNISHED ALL WORK GUARANTEED

THE KRUGER & BLIND CO., MACHINISTS AND ENGINEERS

KEYSTONE BELL | Telephones

511 and 513 Master Street, Philadelphia



KEYSTONE BELT PUMP

FREE

TO ANY ENGINEER

A Tabor, Crosby or American-Thompson INDICATOR

And also 500 other things including every article, tool or device an engineer may want.

These are give free for coupons which come with every pound of our soft and sheet, and every inch of our metallic packing.

Packings For Every Purpose

and which are guaranteed superior to any other made. Engineer's Catalogue is sent to those who ask for it.

FRANCE PACKING CO., Inc.

6514 State Street, Tacony, Philadelphia, Pa.

MANUFACTURERS OF THE FAMOUS

"Steam Stopper," Brands of Metallic, Fibrous and Sheet Packing.

COUPON 000075

This Coupon represents a
ONE POUND PURCHASE
Five of these coupons are equivalent to one certificate and are redeemable according to our premium list at any of our stores.
France Packing Co., Inc.
Headquarters
Tacony, Philadelphia, Pa.

CUT OUT AND SAVE THIS ONE AS A STARTER

France Packings have been on the market for years and are used on some of the largest engines and in the largest plants in the world.

FOR FREE PREMIUM LIST FILL OUT AND MAIL US THE BLANK BELOW.

TEAR OFF HERE

FRANCE PACKING CO., Date_____ 1904

6514 State St., Tacony, Philadelphia, Pa.,

Gentlemen :—Kindly send me premium list and full particulars regarding the indicators and other articles that you are giving to engineers.

My name is _____

My address is _____

(Give complete address)

I am employed by _____

WE HAVE THE CREDIT

of selling more INDICATORS than any other manufacturer. Guess that's so, and there are good reasons for it. They are right in every way—design—workmanship—test of springs—prices—and very easy terms where satisfactory references are given. The extra piston with every ROBERTSON-THOMPSON gives it double the range of any other. To-day is a good time to write for prices and terms.

This is the Box

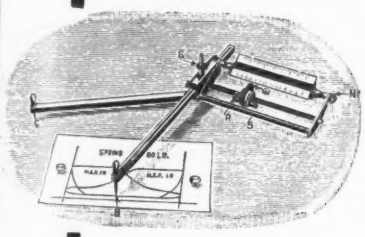
that GENUINE EUREKA is packed in and it's the PACKING you can depend on for long service, easy running of engine, the least friction, and one-half the trouble and expense. Try a box next time you need PACKING.

The More Power

you can get from your engine the more it's to your credit. WET steam consumes power, engine labors—strains itself—forces out the packing. HINE SEPARATOR dries steam and when placed in the exhaust line keeps oil out the boiler.

Save Time

and figure your cards accurately with a WILLIS PLANIMETER. It gives the M. E. P. direct with no chance of error and costs no more than the sloppy kind.



There's Nothing

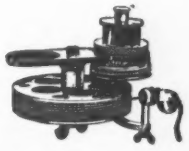
so helpful to an engineer as a good DAMPER REGULATOR and there is none quite so good as the SPENCER. You probably don't know how low in price they are and how easy to connect. You will thank us if you get one.

At the Boiling Point

is where our FEED WATER HEATER will heat your water to with your waste exhaust steam.

Modern Ideas

call for a REDUCING WHEEL. The VICTOR is all that a WHEEL should be and the price is very low.

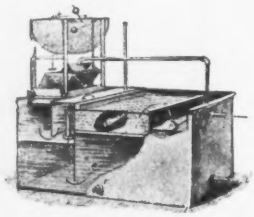


JAS. L. ROBERTSON & SONS

205 FULTON STREET, NEW YORK

SAY!

Don't you know you are wasting money all the time you are running your boilers with muddy and scale forming water.



WELL!

Why not write us for our catalogue and full information?

AMERICAN WATER SOFTENER CO.,

Mutual Life Building
Philadelphia, Pa.

Western Office
Outlook Building, Columbus, Ohio.

U. S. A.

EVERY USER OF POWER AND LIGHT SHOULD READ THE

POWER AND LIGHTING ECONOMIST

tells how to buy best, how to save money, how to improve methods. Thus $1 may save you $1,000. —50c. a copy, $1 a year; Frank H. Knox, Troy, N. Y., and all live newsdealers. Send for great clubbing offer.

BELTING

For Main Driving and General Use
IS A DISTINCT ECONOMY
over any other belting. We will gladly furnish practical proof of this.

MAIN BELTING COMPANY

1219-39 Carpenter St., Philadelphia. 55-57 Market St., Chicago. 120 Pearl St., Boston. 40 Pearl St., Buffalo.

...FOR OVER 14 YEARS...

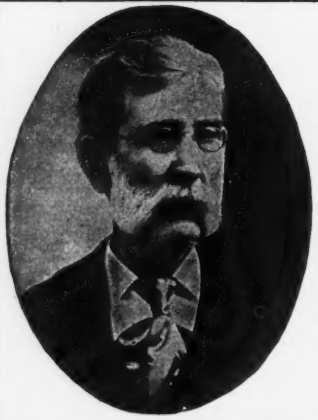
the registered trade mark BROTHERHOOD has been recognized the world over, as the sign of the best overalls made; best in material, cut, workmanship, hence best in comfort, neatness, service. Made by the only overall manufacturer who has worn overalls himself, they are made so good that you are sure to demand them always after a trial. Why not try them? As a matter of consistent principle or from motives of selfish economy, either way, you should wear the

Brotherhood Overalls

Trade Mark Reg'd

H. S. Peters
Member of B.L.F. 3 and B.L.E. 171
—MANUFACTURER—
DOVER . . NEW JERSEY

THE BROTHERHOOD MAN WHO HAS RAISED THE STANDARD OF OVERALLS THROUGHOUT ALL NORTH AMERICA



J. C. McNELLEY

McNELLEY'S AMERICAN BOILER COMPOUND

Our compound is the result of years of experiments by an engineer of long experience, assisted by expert chemists.

American Boiler Compound not only completely removes all scale and incrustation in the boiler, but prevents new from forming, and will, if properly used, keep the boiler absolutely clean and free from all forms of corrosion, such as pitting, grooving, honeycombing.

Send Sample of Water and Sample of Scale if Convenient.

We will be pleased to hear from engineers who will secure trade for us. When writing for information address

J. McNelley, Dept. Mgr., 35 Poplar St., Phila.

SOLD THROUGH

SMITH, KLINE & FRENCH CO.
429-435 Arch Street, - - - Philadelphia, Pa.

"GLADIATOR" Asbesto-Metallic High-Pressure PACKING

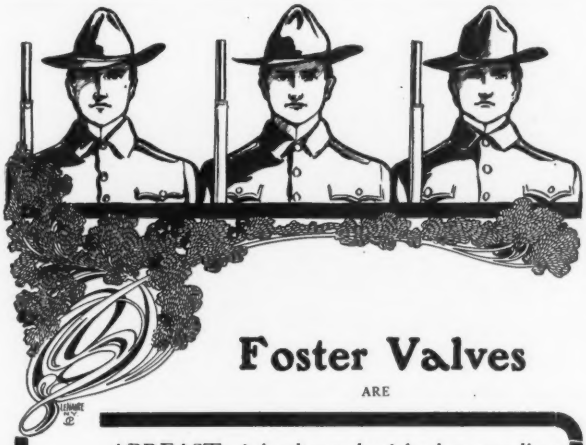
Something Entirely New
SEND FOR SAMPLE

RING

It is not merely a piece of Packing cut the required length and pressed to shape on a mandrel, but is molded in steel dies under hydraulic pressure until it is almost as solid as metal.

They are composed of the same material as the Famous "Gladiator" Asbesto-Metallic Packing.

NEW JERSEY ASBESTOS CO. CAMDEN, N. J.



Foster Valves

ARE

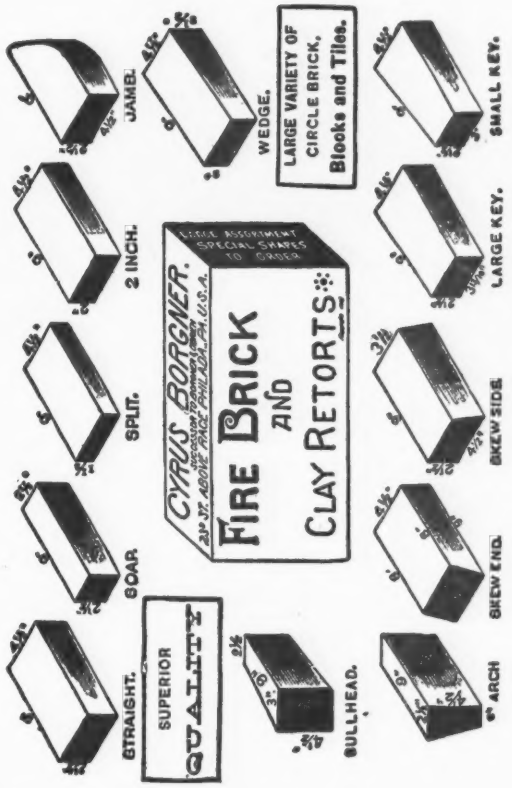
ABREAST of the demands of the day regarding Pressure Regulation.

Now is the time, if ever, to consider the question of steam heat regulation. Let us send you sizes, prices, and full details of operation of a FOSTER "QH" LOW PRESSURE VALVE for pressures up to 15 pounds delivery. This Valve has small inlet and large outlet, and because of its efficiency has been adopted as the STANDARD for all WEBSTER SYSTEM of STEAM HEATING.

CLASS "Q" is practical the same Valve only outlet and inlet are of great size.

Shall we send data?

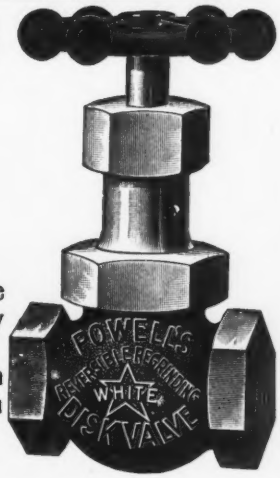
FOSTER ENGINEERING CO.
NEWARK, N. J.



POWELL'S

"White Star"

Regrinding Reversible Seat Valves



have a longer life and are easier to repair than any valve made.

They are sold with a guarantee of satisfaction or your money refunded.

Try one.

Wrought Iron Pipe

Not Steel

Cut to any size and for any purpose. Prompt Shipments to any part of the world guaranteed

Engineers' Supplies and Steam Fitters' Tools

C. J. Rainear & Co.

No. 518 ARCH ST. - - Philadelphia

O. F. Zurn
J. M. Zurn

J. D. Kelley
C. J. Curran

O. F. ZURN CO.

HIGH-GRADE

LUBRICATING OILS AND GREASES

PEERLESS Boiler Cleaning Compounds

Our First and Last Consideration is QUALITY

23 & 25 S. Fifth ST., PHILADELPHIA

If you want the best get Gould's Steam and Water Packing

RING PACKING

In ordering give EXACT diameter of stuffing box and piston rod or valve stem.

See that our name and trademark is on every package.

Gould's STEAM AND WATER Packing

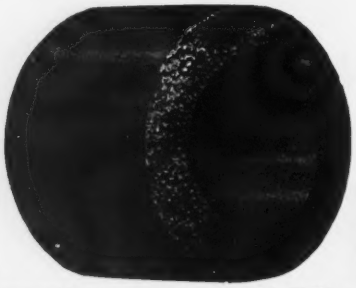
Gould Packing Co.

E. Cambridge, Mass.

REGISTERED TRADE MARK

Albion Chipman, Treas.

East Cambridge, Mass.



PHOTOGRAPH OF PACKING TAKEN FROM A STUFFING BOX OF FOUR INCH ROD

The Packing that lasts as long as the Engine

LARKIN'S

SELF-LUBRICATING METALLIC PACKING

Can't blow out or burn—pliable and elastic—reduces friction—will not scratch or corrode the rod—always fits and any body can fit it. It's the handiest, most durable and most economical packing.

SOLD ON A GUARANTEE. ASK FOR BOOK.

Pennsylvania Electrical & Railway Supply Co.

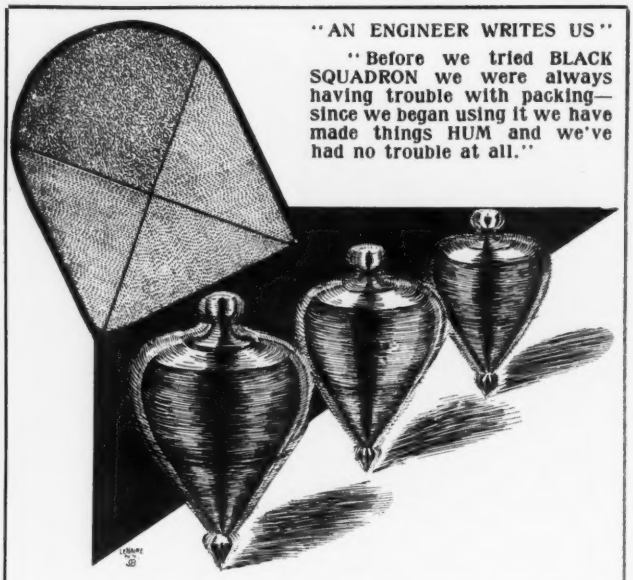
General Sales Agents

PITTSBURGH, PA., U. S. A.

THE HOLLAND COMPANY, Chicago, Ill., and San Francisco, Cal.
W. G. BEAMER, Beaumont, Texas. E. A. KNOWLTON, Boston, Mass.
A. H. TRUAX, Ripley, Tenn. G. S. GRANNIS, New Haven, Conn.
W. J. SHIVERS, Macon, Ga. A. E. WILLSON, Indianapolis, Ind.
C. M. BLAIR, Tidioute, Pa. W. S. MALONE, Lisbon, Ohio.
A. StC. DUNSTAN, Auburn, Ala. J. D. HOLDERMAN, Somerset, Ky.
WILLIAM MARTIN, 10 Barclay Street.

"AN ENGINEER WRITES US"

"Before we tried BLACK SQUADRON we were always having trouble with packing—since we began using it we have made things HUM and we've had no trouble at all."



Never take a chance with unreliable packing, you cannot afford to. The growing popularity of BLACK SQUADRON for WEDGE PACKING is entirely due to its peculiar reliability.

We Send a FREE SUPPLY

to any engineer sending us his name and address, and with it a very useful engineer's MEMO BOOK FREE ALSO.

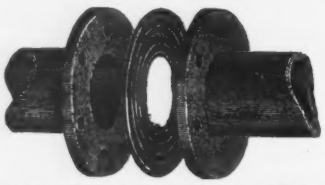
Remember, no cost for BOOK or PACKING

CANCOS MANUFACTURING CO.

146 N. Second Street, Philadelphia

OUR PATENTED MINERAL WOOL

PIPE COVERING



AND

Copper Gaskets

They Save Steam and Make Absolutely Tight Joints

United States Mineral Wool Co.

143 LIBERTY STREET, NEV YORK

BEST AND CHEAPEST SAMPLES FREE

Our pretty ornamental metal sign, reproduced below, will be found in the warehouses of all the first class jobbers of engineers' supplies in the United States.

Genuine

Detroit

SIGHT FEED

Lubricators

SOLD HERE

The Detroit Lubricator Co., Makers.
Detroit, Mich., U.S.A.

Buy only genuine goods. Avoid counterfeits.
Catalogue on application.

DETROIT LUBR CATOR CO.

DETROIT. MICH.

THE BEST RUBBER VALVES AND DISCS

HARD— for Hot Water, Oil and AIR Pumps.

MEDIUM— for Steam and WATER

SOFT— for Cold Water.

J. JOHNSON. TRADE MARK.

Do not **BREAK, CHIP** or **SEPARATE**

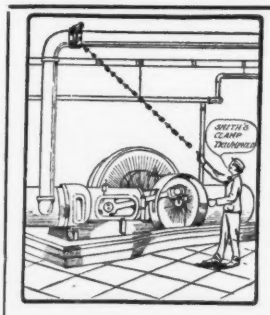
Resist high **TEMPERATURE**

DURABLE

SAYEN & SCHULTZ

OXIDIZED RUBBER WORKS

13th and Commerce Sts. PHILADELPHIA, PA.



Stop-a-Leak

WITH

The Smith-Clamp

ASK

YOUR DEALER OR

W. CLIFFORD SMITH, Manufacturer, 138 N. Sixth St., Philadelphia

STEAM FITTING

if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN, Shop, 726 Sansom Street, Philadelphia, Pa.

'Phones: Bell-Walnut 1271 a Keystone-Main 1-71 JOBBING A SPECIALTY

RED SEAL BOILER COMPOUND

REGISTERED TRADE MARK

Agents Wanted Everywhere

WRITE FOR TERMS

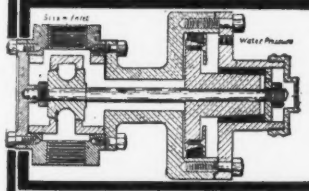
THE CHERRY CHEMICAL COMPANY

MANUFACTURERS

Office; 1215 Filbert Street, - Philadelphia, Pa.

Circulars, Prices and Directions Furnished on Application

MULLINS AUTOMATIC CONTROLLER



...FOR BOILER FEED PUMPS...

Delivers more water to boilers when steam-pressure is high, and less when it is low, which not only holds the water uniform, but also tends to hold steam pressure uniform, saving fuel that is wasted in pumping too fast and flooding boilers when fires are low. It will outlive any pump, and increase the life of the pump one-half. WRITE US FOR DETAILS.

THE FEDERAL VALVE CO., 2534 WESTERN AVE. SEATTLE, WASH

The Garfield Ejector

for raising water from deep wells, mines or pits; filling or emptying tanks; raising and transferring liquids, hot or cold, in tanneries, dye-houses, etc., is not surpassed.

SEND FOR CATALOGUE.

The Ohio Injector Co.

S. Main Street, WADSWORTH, OHIO.

BOOKS

FOR EVERY DAY USE

In the Engine Room

How to run Engines and Boilers

A book full of helpful information for firemen and engineers.
It tells what you want to know in a plain practical way that sticks.

By mail $1.00

A set of 6 large plates to detail with descriptive matter of a high speed steam engine and centrifugal governor. 50 Cents.

Explained simply and clearly. Brought up to the latest American practices. You can use it.

By mail $1.00

SPON & CHAMBERLAIN

Publishers of Books for Engineers

Dept. P. E., Liberty Bldg., **New York, U.S.A.**

Algebra

is an interesting and profitable study. Every young engineer should have a knowledge of Algebra. It may seem a needless luxury now, but the day is not very far off when it will be necessary to an engineer's advancement. If you want to take up the study of Algebra at no expense to yourself, all you have to do is to go round among your engineer friends and get up a club of three subscribers for The Practical Engineer, at 50 cents each, and we will send you a copy of Algebra Self-Taught

Free

Its a good book and easily understood, but if you don't want to get up a club, we will send you a copy of it and give you a year's subscription to "The Practical Engineer" both for $1.00.

If you don't want to study Algebra, we have several other "good things" that we give as premiums for clubs of subscribers, all of which are shown on our

PREMIUM CIRCULAR

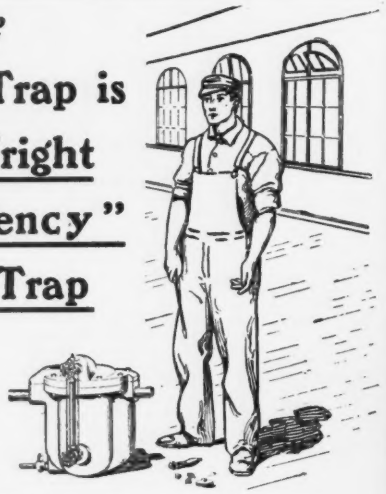
The Practical Engineer

46 North Twelfth Street

PHILADELPHIA

The

Simple Trap is The Wright "Emergency" Steam Trap



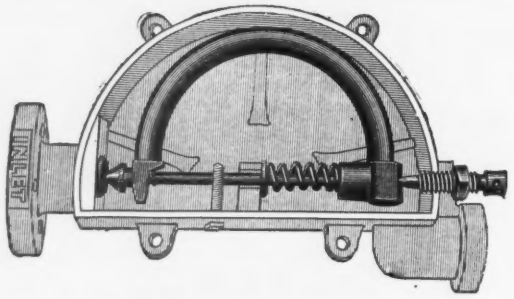
If necessary, you can renew the valve seats in five minutes time with out disconnecting trap, or even taking the cover off.

Removing an iron plug with a wrench, and the valve seats by means of a screw-driver, does the work.

Perfect operation guaranteed on varying steam pressures up to 250 lbs., without requiring special adjustments or change of valves.

LET US SEND DETAILS

WRIGHT MANUFACTURING CO.
72 Woodbridge Street DETROIT, MICH., U. S. A.



Heintz Steam Savers

When properly installed—and we furnish plans and instructions without charge—the Heintz will save at the coal pile, its cost several times a year, besides increasing greatly the efficiency of any heating system or steam controlled apparatus to which it may be attached.

Reliable, accurate, durable, no floats, no complications, just results. Guaranteed or no pay.

WRITE FOR BOOKLET "4"

William S. Haines Co.

136 SOUTH FOURTH STREET. PHILADELPHIA

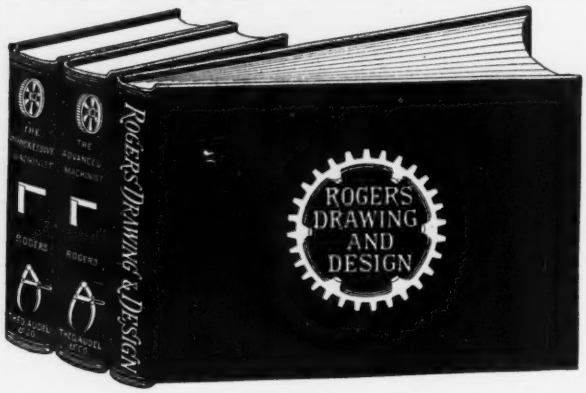
Pacific Coast Agents, California Engineering and Construction Co.
RIALTO BUILDING, SAN FRANCISCO, CAL.

ROGERS' Machinists' Library

LIST

The Progressive Machinist -	$2.
The Advanced Machinist -	2.
Mechanical Drawing and Design	3.

SEND POSTAL FOR MACHINISTS' LIBRARY



Each of the books in the Library is a complete treatise in itself and can be purchased separately at price above named.

PLAN of WORK

The three volumes composing the "Machinists' Library" have been issued just long enough to receive the most hearty approval of the best representatives of the Engineering and Mechanical world.

The books composing the library are intended to be: educational, and progressing from the simple to the more complex subjects; plain books for those already engaged, or soon to be, in the practical application of the theory of mechanics; each volume is complete in itself, while progressive in the series. The books are each supplied with a ready reference index, which enables the quick use of their contents.

The volumes are strongly and handsomely bound in black cloth, with titles and edges in gold; they contain 1,204 pages. 1,244 illustrations, many of which are full pages, with 3,000 ready references; they are printed on fine surface paper with large, clear type. Each book stands 8½ inches in height, and the three packed for shipment weigh over 7½ lbs. No works of equal value have ever been offered to the machinists' and allied trades, and no one, from the Superintendent and Owner to the Apprentice, can afford, considering the price and terms, to be without them.

MONTHLY PAYMENT PLAN

Rogers' Library is supplied whenever desired on easy terms. Upon receipt of one dollar, and agreement to remit the same amount each month for six months, and accompanied by the name of one or two persons of whom inquiry could be made if desired, regarding subscriber's reputation for keeping business promises, the set will be shipped to any part of the world with all transportation charges prepaid.

CUT OUT AND MAIL TO-DAY

I accept your offer to supply me with ROGERS' MACHINIST'S LIBRARY (3 vols.) for $7. Enclosed find $1 as first payment; the balance I agree to remit in $1 monthly installments.

Name_____ Occupation _____

Address _____

You are at Liberty to consult the person named below as to my reputation for keeping business promises.

Name_____ Occupation _____

Address_____

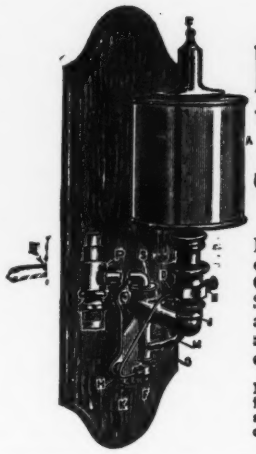
P. E.

THEO. AUDEL & CO.
Educational Book Publishers
63 Fifth Avenue - - - NEW YORK

THE CARR PUMP GOVERNOR

Superior to any pump governor on the market "why" Because the cylinder will not LIME, Prevents the pump from RACING in case of a bursted main or hose, Fitted with Renewable Compensating Valve and Seats, Regulation perfect. Especially adopted for Fire and Water Works Pumps, Send for catalogue, 30 days trial.

E. M. CARR,
NEW CASTLE, IND., U. S. A.

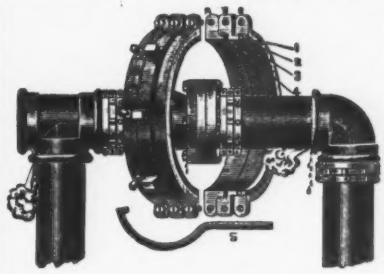


IMPROVED
Kellam Damper Regulators
The Simplest and Closest Damper Regulator.
Manufactured by
J.E.Lonergan&Co.
211 RACE ST., PHILA., PA.

Brass Founders and Finishers and Makers of Pop Safety Valves, Water Relief Valves, Oil Cups and Lubricators, Steam Pressure Regulators and other safety steam appliances.

Old Kellam Regulators Repaired.
Correspondence Solicited.
Mention this paper if your inquiry is prompted by the sight of this advertisement. Catalogue D free on application.

Climax Steam Joint Clamp Knowledge

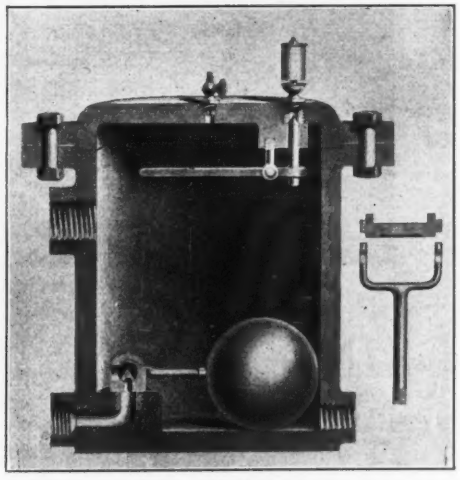


is a good thing to have, and comes in handy when that joint begins to leak, and you wish to repair it permanently and economically without shutting steam off the pipe

OUR CATALOG will be of interest to you, and will make you wise on some other good things

JAMES McCREA & CO., Manufacturers
67 W. Washington Street, CHICAGO

ENGINEERS SEE FREE OFFER



SEND FOR BOOKLET, C.

PACIFIC COAST AGENTS
MADISON MERCANTILE CO.,
San Francisco, Cal.

MR. JOHN T. LINDSTROM.
Allentown, Pa.

W. H. STOKES MILLING CO.
WATERTOWN, S. D.

Dear Sir:—

We are very much pleased with your Corliss Valve Steam Trap, so much as that we wish you to send us Two more exactly like it, you have marked it No. 2 on your bill, and we want this piped, one for one inch, and one for 1-¼ inch.

Kindly send them forward as soon as possible. This is the only Trap we have ever seen that is worthy of the name.

Very truly yours,
W. H. STOKES, Milling Co.
W. H. Stokes, President.

Now is the time to look after your Steam Heating System, get a good reliable Steam Trap and be through with Repairing Traps again the coming winter.

THE LINDSTROMS, CORLISS VALVE STEAM TRAP WILL GIVE YOU REST, AND KEEP THE WATER OUT OF THE PIPES WITHOUT WAISTING ANY STEAM.

FREE

A Blue Print Showing how to Set Valves on Corliss Engines Simple and Compound with One and Two Eccentrics FREE with every Steam Trap Order.

CYLINDERS REBORED

Expert Machinists sent to all parts of the country with Special Portable Tools to Rebore Cylinders in their present position from 4 inches to 80 inches in Diameter, No matter what the trouble is with your Engine or Pumps we can help you.

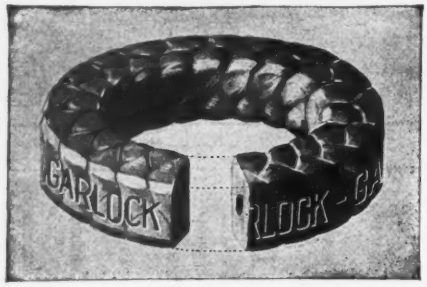
JOHN T. LINDSTROM
214-216 S. Third Street ALLENTOWN, PA.

The Garlock Trade Mark

on Packings, Hose, and Mechanical Rubber Goods is a Symbol of Reliability, Efficiency and economy.

AS ENGINEERS are deeply interested in goods of merit that enter into operation of their plants, we present in the following two Garlock Products which are absolutely Reliable, Efficient and Economical, and stand without an equal in the world.

This is a broad statement to make, but our experience of the last twenty-five years, and the results of tests made in the largest power plants in the world, which have adopted our goods, warrant the assertion. We invite the hardest and the fullest investigation of their merits.



No. 99.

Garlock Waterproof Hydraulic Packing for Hydraulic Pressure

up to 20,000 pounds per square inch on Lifts, Accumulators, Hydraulic Cranes, Elevators, Pump Plungers, and all forms of Hydraulic work.

The enormous sales of this packing attest the high favor in which it is held by mechanical engineers.

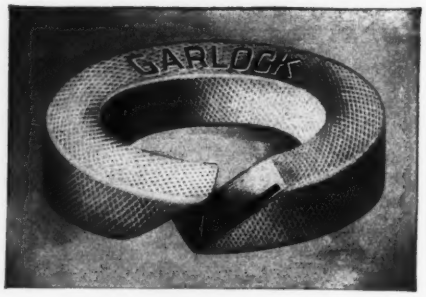
Garlock High Pressure Packing

RING, SPIRAL ORICOIL

is the only fibrous packing that gives entire satisfaction on high speed and marine engines, locomotives, rods running in oil, grease or chemicals.

Excels every other packing for expansion joints.

One of the best proofs that we have the only successful High Pressure Packing on the market is that it is imitated by every important manufacturer of packing in the world, but has never been equalled.



No. 200.

THE GARLOCK PACKING CO.

Main Office: Palmyra, N. Y., U. S. A.

FACTORIES

PALMYRA, N. Y. SAN FRANCISCO, CAL. ATLANTA, GA.
DENVER, COLO. HAMBURG, GERMANY

STORES

Philadelphia	Chicago	St. Louis	Palmyra, N. Y.
New York	Pittsburg	Atlanta, Ga.	San Francisco
Boston	Cleveland	Denver	Hamburg, Germany

What to Do Today

Decide to shovel less coal next year.
Decide not to be bothered with so many repair jobs around the boilers.
Decide that you will keep your boilers free of scale.
Decide to save your firm's money.
Decide that you want one of the above

Leather Calendars Free

The first step towards realizing all these good intentions, is sending the coupon and sample of scale from one of your boilers. In return we will send you, free of cost, one of the above illustrated, handsome and convenient leather calendars. We will also send some facts that will cause you to decide at once that

Lord's Boiler Compounds

save work and money. Send that coupon today.

Lord. Scranton.

The Geo. W. Lord Co.
2238-50 N. 9th Street,
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the inch and metric foot rule.

Number of boilers in use _____
Capacity of each boiler _____
Frequency of cleaning boilers _____
Frequency of opening the blow-off during working hours _____ *River or other source of water supply* _____
Boilers are used about _____ *hours out of 24*
Boiler compound now used _____
Name _____
Street and Number _____
City _____ *State* _____
Firm's Name _____
Pract. Eng. *Date* _____ 1904. 6

The Practical Engineer's Favorites

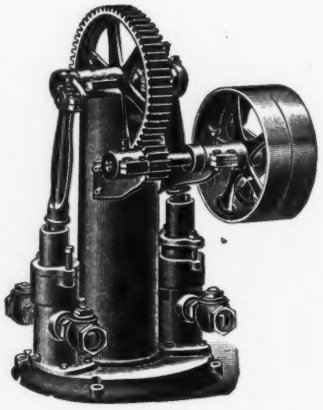
The Patterson-Berryman Feed Water Heater and Purifier

IMPROVED TO DATE

By means of exhaust steam from the engine, it supplies pure hot water for boilers (or other purposes) at 200 degrees F. or above, saving fuel which would otherwise be used in heating the water to that temperature.
This means a reduction of from 10 to 20 per cent. of the coal bill.

PATTERSON BELT PUMPS

Every engineer knows how extravagantly steam pumps use steam. The power required for a Belt Pump would hardly be missed. And it is not necessary to buy one of the expensive kind. Ours is simple, strong and fully guaranteed.



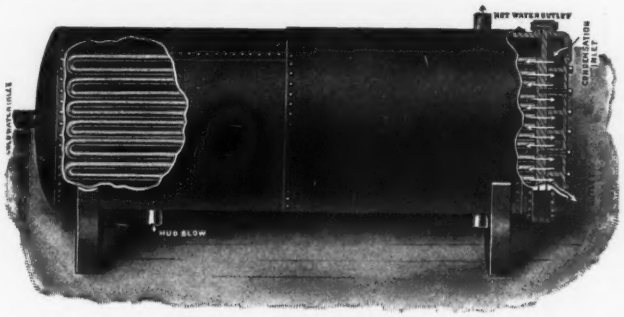
PATTERSON EXHAUST HEADS

Are you tired of having that exhaust pipe spattering greasy spray over the roof, walls, walks and your clothes? Possibly the neighbors are too.
Wouldn't it be better if the vapor floated away *dry and noiselessly?*

WRITE FOR CATALOGUE

FRANK L. PATTERSON & CO.

24 CORTLANDT STREET **MANUFACTURERS** **NEW YORK**



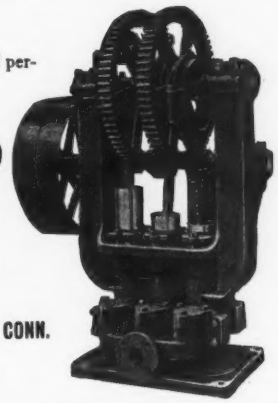
The Gleaner TRADE MARK

The **Gleaner** represents the acme of perfection in feed water heating.

THE

Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.



MANUFACTURERS OF

The "Berryman" Feed Water Heater and Purifier.

I. B. DAVIS & SON, HARTFORD, CONN.

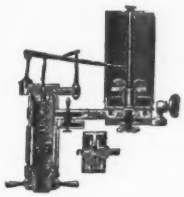
WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO, 125 N. 4th St., Philadelphia

As we have previously announced, the price of our course of Indicator Instruction will be $60.00, and this is the LAST CALL for the present low rate.

Remember, we include with this course an

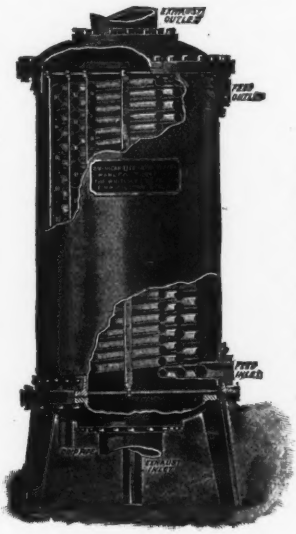
INDICATOR FREE



of all further expense, and you can enroll for cash, or on installments of $5.00 per month and have the indicator to practice with while studying. Full particulars may be had by addressing

A. C. Lippincott
GENERAL MANAGER
INDICATOR INSTRUCTION CO.
Newark, N. J.

THE AMERICAN STANDARD COPPER COIL FEED WATER HEATER



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.
HARTFORD : CONNECTICUT

Size vs. Saving

Bulk is not everything. Even the builders who claim to make "the biggest heater for the money" don't always employ the doctor who gives the largest doses.

WEBSTER
FEED-WATER HEATERS
AND PURIFIERS

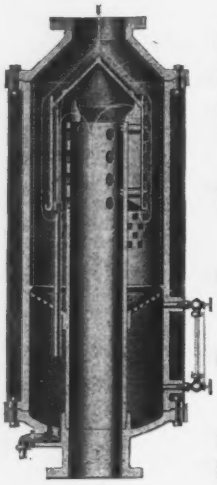
will often do far more work than heaters that fill far more space.

Compare efficiency, not size. Size is what you pay rent for.

Write for Booklet F 13.

WARREN WEBSTER & Co.
CAMDEN, N. J.

Sweet's Separators



Our steam separators deliver steam containing less than one half of one per cent. of water.

Our oil separators remove 99 per cent. of the oil.

We can prove they do it and give good reasons why.

In addition they have size and are machines.

Made in all styles, also make Exhaust Heads and Steam Traps.

Direct Separator Co.

220 Marcellus Street

Syracuse : : New York

AT THE WORLD'S FAIR

Baum Steam Separators

VACCUM STYLE

Oil Extractor

STANDARD FORM

Protect 6,500 H. P. Engines.

Baum Vacuum Oil Separators

Purify and Exhaust from same Engines

Can be seen in operation, Blocks 45, 46, 50, Machinery Hall. Our Exhibit, Bock 22 Machinery Hall.

Send for catalog.

BAUM SEPARATOR & MACHINE CO. MANHEIM, PA.

Horizontal Style for live Steam or Oil Service.

BERRYMAN

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes

We Build Heaters for Every Purpose and Condition

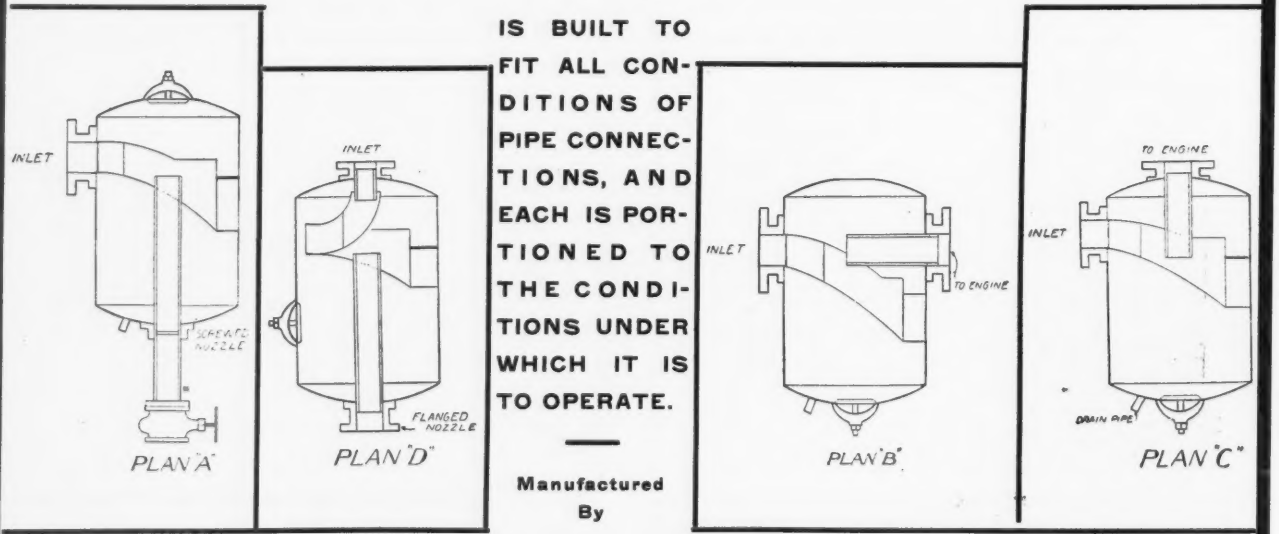
THE KELLEY PATENT

IMPROVED BERRYMAN WATER TUBE FEED WATER HEATER AND PURIFIER

Benj. F. Kelley & Son - Makers

91 Liberty Street, NEW YORK

The Simonds Steam Receiver and Separator

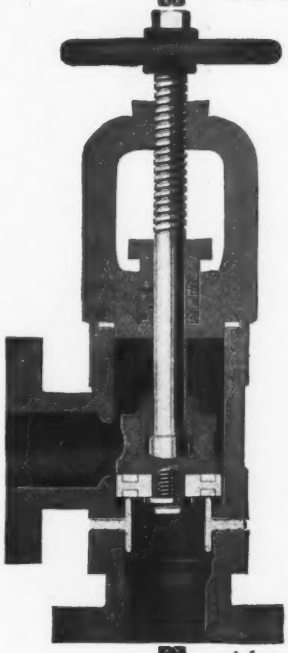


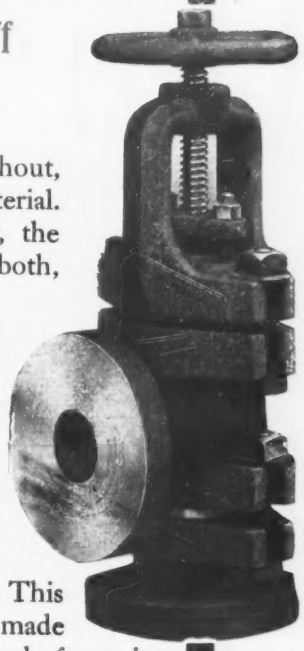
FRANK A. SIMONDS

421 HOUSEMAN BUILDING GRAND RAPIDS, MICH.

A NEW VALVE FOR NOTHING

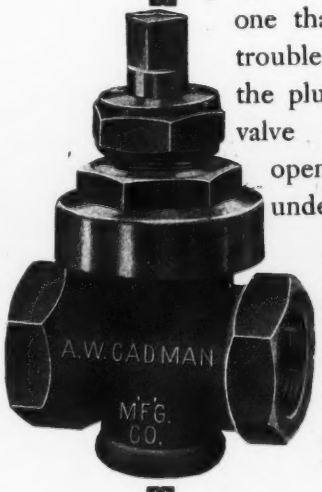
Cadman's Indestructible Blow-off Valve

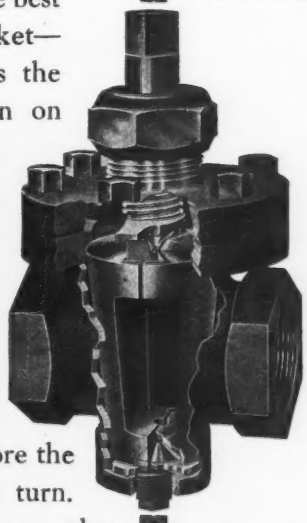




is made, throughout, of the best material. When, eventually, the seat or disc, or both, become worn—the condition that necessitates the removing or an ordinary valve—you merely reverse them and you have a new valve at no cost, and little trouble. This change can be made without removing the body from its position.

A Frictionless "Split Plug" Valve





We manufacture the best plug valve on the market—one that overcomes the troublesome friction on the plug when the valve is being opened or closed under pressure. It is so constructed that the lateral pressure is relieved before the plug has to turn. This makes the process practically frictionless.

It will pay you from the stand-point of both labor and expense to get further particulars on these valves. Write to-day.

A. W. CADMAN Mfg. Co.

THE OLDEST BRASS WORKS IN PITTSBURG

Pittsburg, Pa.

Clean Boilers FREE

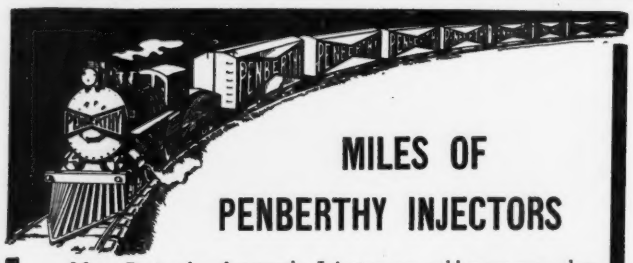
from **Corrosion** and **Foaming** is the reason why "**C.C.C.**" boiler compounds have become so popular.

WRITE FOR OUR PROPOSITION

No Cure, No Pay—That's our way

Continental Chemical Co.
2923 N. Broad Street PHILADELPHIA

Analytical Chemists and Manufacturers of Boiler Compounds.



MILES OF PENBERTHY INJECTORS

More Penberthy Automatic Injectors are sold every year than any other injector known. The Penberthy Injector is standard among engineers, and its name is its highest guarantee of honest, efficient service. Why experiment with unknowns? Other injectors claim to be as good as the Penberthy, but it is still the favorite of over 350,000 engineers. Get on the main line to success by insisting on Penberthy Injectors.

THE PENBERTHY FORCE FEED LUBRICATOR gives a positive feed of oil, and can be regulated to a fraction of a drop. It is not effected by changes of temperature. Simple in construction and easily adjusted. The double interchangeable ratchets give it twice as long life as other lubricators.

Write for catalogue. It tells all about our specialties for the Engine Room.

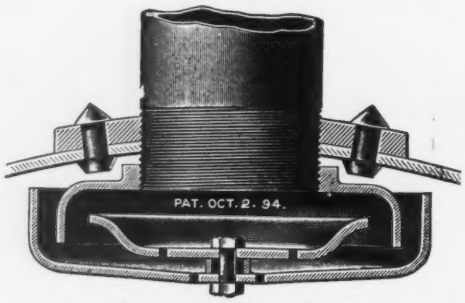
Penberthy Injector Co.
344 Holden Avenue,
DETROIT, MICH., U. S. A.
Largest manufacturers of Injectors in the world.
The Penberthy Bulletin sent free for 3 months.
Penberthy Injector Co., Ltd.
Windsor, Ont.

THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.



Compound Separator

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

The Kutztown Foundry and Machine Co.

WORKS:

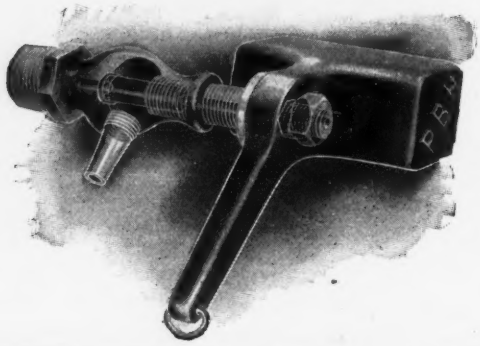
KUTZTOWN, PENNA.

Philadelphia Office: Fidelity Building, Broad above Arch Street.

GET ONE FREE

Put it on your boiler, and give it a good trial for a month; if it gives you absolute satisfaction, keep it, and pay for it, otherwise send it back at our expense.

"P. B. H." WEIGHT GAUGE COCK



There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

Paul B. Huyette, 1245 BETZ BUILDING PHILADELPHIA

U.S. Automatic Injector

HURRAH FOR

U. S. INJECTORS

THEY ARE "THE BEST"

Unanimously re-elected "THE BEST" on the "Solid Merit" ticket by over 200,000 engineers. Adopted by the United States government. Endorsed as "THE BEST" by leading authorities.

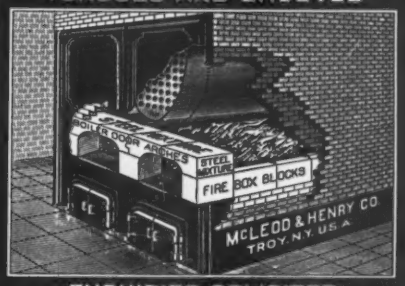
Buy from the dealer. Demand the genuine.

Write for catalogue, and "Engineers Red Book," a valuable pocket reference, which answers over 500 important questions.

AMERICAN INJECTOR CO.
Detroit Mich., U. S. A.

U. S. on every injector and our "capacity guarantee."
Remember, no other injector is "just as good,"

YOU CAN SAVE
MONEY
BY USING
"STEEL MIXTURE"
BOILER DOOR ARCHES
AND FIRE BOX BLOCKS
TONGUED AND GROOVED



ENQUIRIES SOLICITED
McLEOD & HENRY Co.
TROY, N.Y. U.S.A.

This Book Free

Send us Three Subscriptions to The Practical Engineer at Fifty Cents each and we will send you Free a copy of

Hand Book of Corliss Steam Engines

BY FRANK WILLIAM SHILLITTO, JR.

This book describes, in a comprehensive manner, the Erection of Steam Engines, the Adjustment of Corliss Valve Gear, and the Care and Management of Corliss Steam Engines. It is illustrated by 64 Original Engravings. 200 Pages.

Price, $1.00, or will be sent Free for a Club of Three Subscribers to The Practical Engineer at 50 cents each.

We also have other books which we give as premiums for clubs of subscribers.

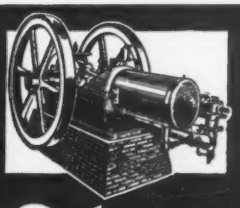
AGENTS WANTED. We want a few good agents to solicit subscriptions for The Practical Engineer on liberal commission basis. Hustlers can make good money. Write for terms, stating qualifications, experience, etc.

The Practical Engineer is the largest and best mechanical journal ever published anywhere in the world for fifty cents a year, and getting subscriptions for it is just like finding money.

Address Department A.

The Practical Engineer

46 N. TWELFTH ST., PHILADELPHIA, PA.



Olds Gas and Gasoline Engines

Each engine is fully tested before it leaves our factory to its full indicated horse power. Its simplicity of construction and perfection of mechanical principles have been amply demonstrated during the past 23 years. Olds engines are standard the world over.

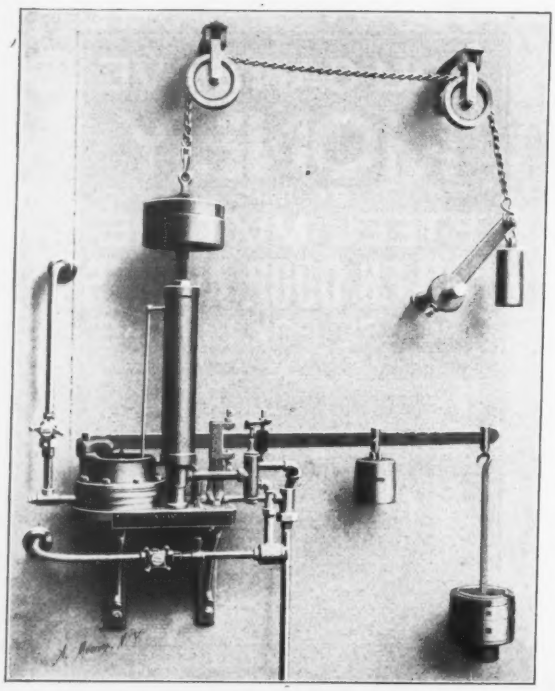
Stationary Engines, 2 to 100 H. P.

Portable Engines, 8 to 35 H. P.

We will send full information and new illustrated catalog upon request.

OLDS GASOLINE ENGINE WORKS

244 River Street LANSING, MICHIGAN



$50.00

FOR No. 3.

PATTERSON (PERFECTED) GRADUATED SCALE BEAM REGULATOR

Best and Cheapest Hydraulic Damper Regulator in the world.

Scientifically Designed-Simple in Construction.

Will handle 1 to 20 Dampers on (1) pound variation.

Sent anywhere on 30 days trial, Satisfaction guaranteed or no pay.

Any "Supply House or Steam Fitter," would furnish the Patterson (up-to-date) Regulator.

PATTERSON MANUFACTURING CO.

No. 301 N. Holliday Street, - - BALTIMORE, U. S. A.

BE WISE

Years ago there were three wise men who saw a certain Star, and by its use obtained great things.

To-day these wise men have become a multitude and have obtained clean boilers by the use of RED STAR.

If you are troubled with scale or grease in your boiler, write us about it or send for our 96 page Booklet, treating on boilers, boiler scale and RED STAR BOILER COMPOUND.

LAKE ERIE BOILER COMPOUND CO.

192-198 CHICAGO STREET BUFFALO, N. Y.

BRANCH OFFICES

NEW YORK PHILADELPHIA NEWARK PITTSBURG KALAMAZOO CINCINNATI

Please mention this paper when writing.

Cyclopedia of Applied Electricity

A Practical Guide for Stationary Engineers, Electricians, Engineering Students and All Persons Interested in Electricity.

The installation, care and management of electrical machinery is becoming one of the regular duties of stationary engineers. It is therefore necessary that they should have a thorough working knowledge of electricity. The CYCLOPEDIA covers the whole field from the fundamental principles to such subjects as Installation and Management of Dynamos and Motors, Lighting, Wiring, Alternating Currents, etc. Its value to a progressive engineer looking for advancement, is self-evident.

Five Volumes—2500 Pages—size of page 8 x 10 inches—fully indexed. Handsomely and durably bound in three-quarter Morocco, profusely illustrated with 2000 diagrams, full page plates, sections, tables, formulae, etc. Invaluable alike to the expert and the apprentice. Every section written by an acknowledged authority. Prepared especially for practical, everyday use. A text-book and a reference work combined, as every volume is followed with a carefully prepared list of practical test questions to impress the important points on the reader's mind.

It includes a comprehensive treatise on the **Management of Dynamos and Motors** by Prof. F. B. Crocker, of the Crocker-Wheeler Co., taking up installation, assembling, operation, care, locating faults, etc. **Electric lighting** takes up the subject of lighting for mills, shops, drafting rooms, and includes a discussion of the **Nernst, Cooper Sewitt, Osmium** lamps, etc. The importance of **Alternating Current** work is everywhere recognized, but heretofore difficult mathematics have made it next to impossible for any but college men to take it up. The "Cyclopedia of Applied Electricity" contains the **only** treatise which covers Alternating Current work thoroughly in simple language **without advanced mathematics.** This feature alone makes the work invaluable to practical men.

A limited number of introductory sets will be sent

FREE

for examination as soon as received from the press. We are printing an edition for our own use. By increasing the edition we can reduce the cost of manufacture. We are willing to share this saving with those who order **now for future delivery.** The regular price is $25.00. **We will accept reservation orders until the books go to press, at $12.50—less than half the regular price.** The books will be sent by express, prepaid, on approval and may be returned at our expense if not in every way satisfactory. **Those desiring to have a set reserved at the reduced price** must send $2.50 with their application as an evidence of good faith. This amount will be credited on the books, or returned if they are not kept. No further payments need be made until February 1st, when payment of balance ($10) at the rate of $2.00 per month must begin. No reservations can be made at the present advanced sale price ($12.50) after the edition goes to press.

SOME OF THE WRITERS

PROF. F. B. CROCKER, head of Department of Electrical Engineering, **Columbia University;** author of the sections on Storage Batteries and Management of Dynamo Electric Machinery.

PROF. WILLIAM ESTY, head of the Department of Electrical Engineering, **Lehigh University;** author of the section on Alternating Current Machinery.

H. C. CUSHING, Jr., Wiring Expert and Consulting Engineer; author of the section on Wiring for Light and Power.

PROF. GEORGE C. SHAAD, University of Wisconsin; author of sections on Power Transmission, Electric Lighting and Central Stations.

J. R. CRAVATH, Western Editor of the **Street Railway Journal;** author of the section on Street Railways.

CHAS. THOM, Chief of **Quadruplex Department Western Union** Telegraph Co.; author of section on Telegraphy.

WILLIAM BOYRER, Telephone Expert and Consulting Engineer.

PROF. LOUIS DERR, Mass. Institute of Technology;
PROF. HARRIS C. TROW, American School of Correspondence.

PARTIAL TABLE OF CONTENTS

PART I.—Static and Dynamic Electricity—Primary Batteries—Ohm's Law—Wire Calculations—Electrical Measurements—Wiring for Light and Power—Electric Telegraph, including the Duplex and Quadruplex.

PART II.—Theory of Dynamo-Electric Machinery—Design and Construction of Dynamos and Motors—Types of Machines—Storage Batteries, including Theory, Management and Types—Testing Efficiency.

PART III.—Incandescent and Arc Lighting—Electric Railways, including Car Wiring, Line Construction, Third Rail and Multiple Unit Systems—Management of Dynamo-Electric Machinery—Power Station Work—including Boilers, Engines and Electrical Machinery—High Tension Transmission.

PART IV.—Theory of Alternating Currents—Construction, Types and Operation of Alternators, Transformers, Induction Motors, Synchronous Motors and Rotary Converters.

PART V.—The Telephone—Instruments—Line Construction—Switchboards—Exchanges—Operation and Maintenance—Common Battery System.

Coupon—Cut out and mail to
AMERICAN SCHOOL of CORRESPONDENCE

Enclosed find $2.50 for first payment on special half-price advance sale of Cyclopedia of Applied Electricity. The balance ($10) I will pay in monthly payments of $2.00 each, beginning February 1st.

It is understood that I may return the set at your expense within five days and that you will refund the amount paid if the set is not wholly satisfactory to me. Also that you will return the $2.50 if my order is received too late for the half-price sale.

Name .....

St. Address .....

City ..... State .....

Practical Engineer.—Dec.

American School of Correspondence

AT

ARMOUR INSTITUTE OF TECHNOLOGY, CHICAGO, U. S. A.

DANIEL W. PEDRICK,
MORRIS G. CONDON
ALBERT D. PEDRICK

L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870

Sole Makers of
ST. JOHN SELF ADJUSTING
CYLINDER PACKING.

H. B. UNDERWOOD & CO.

GENERAL MACHINISTS.

1025 HAMILTON STREET PHILADELPHIA, PA.

Engines, Pumps *and* Machinery Repaired Quickly *and* Well

The old saying that "a stitch in time saves nine" applies to a steam engine with greater force than to most things, for when an engine is in need of repairs, she not only gets worse very rapidly but she becomes a mighty extravagant servant and soon wastes more fuel than would pay the repair bill. We make a specialty of

Repairing Steam Engines *and* Pumps

WE REBORE CYLINDERS IN PRESENT POSITION FROM THREE INCHES TO 110 INCHES IN DIAMETER

Dynamo Commutators Turned Off Without Removal.
Builders of Dash Pots.
Portable Planer for Facing Off All Sizes of Hammer Blocks in Present Position
Blacksmithing. Steam Power Hammers.
We send Experienced Mechanics with Portable Tools to All Parts of the Country to Repair Engines and Pumps.
Portable Milling Machine for Milling off Valve Seats in Position.
Ice Machine Repairs a Specialty.
Sole Agents for St. John Self-adjusting Cylinder Packing.
Send for Our Book of Useful Hints for Engineers.
Crank-shaft Journals of all sizes turned off without removal.

We Have a Special Machine for Reseating Valves in Position, from 1 to 12 inches in Diameter

WE ALSO MAKE A SPECIALTY OF GEAR CUTTING, INTERNAL AND EXTERNAL, UP TO 36 INCHES DIAMETER

DANIEL W. PEDRICK.
MORRIS G. CONDON
ALBERT D. PEDRICK

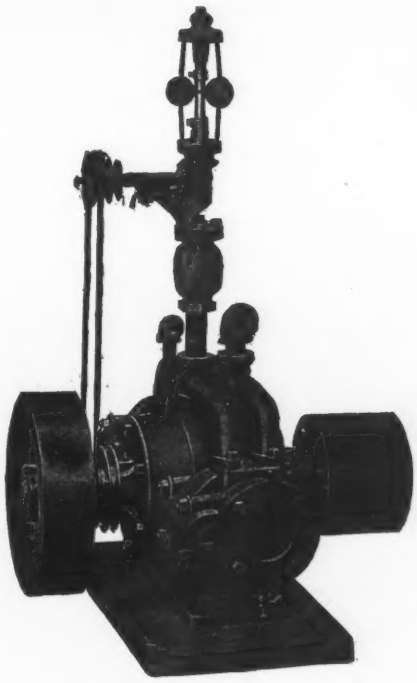
L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870

Sole Makers of
ST. JOHN SELF ADJUSTING
CYLINDER PACKING.

H. B. UNDERWOOD & CO.

GENERAL MACHINISTS,

1025 HAMILTON STREET PHILADELPHIA, PA.



Two-Cylinder Steam or Air Motor

For driving special tools and machinery.
Driven by steam or compressed air.
Floor space 19x19 inches, weight 147 pounds. Equal to any electric motor and more economical.
Easily taken apart, easily assembled.
No shop is complete without at least one of these handy little engines.
Can be used for a thousand different purposes, and will save its cost a dozen times a year.

THIS LITTLE MOTOR IS

New, Novel and Mighty Useful

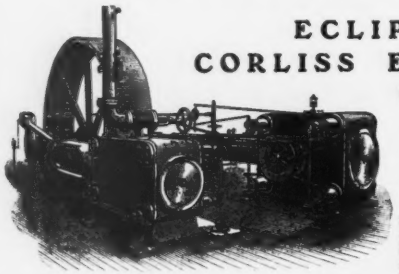
Look at it. Read about it and think about it; perhaps there is a place about your establishment where you can place one to advantage.

Write for circular and price

FRICK COMPANY

ENGINEERS

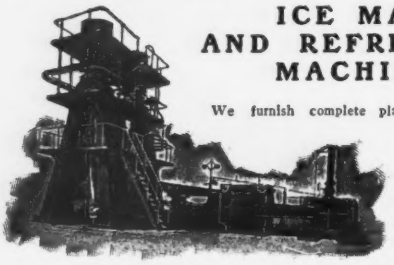
WAYNESBORO, FRANKLIN CO., PA.



ECLIPSE
CORLISS ENGINES

Plain Corliss Engines, Cross and Tandem Compound, Vertical Corliss Engines.

Corliss Engines of any type, 40 to 2000 horse power, specially adapted for electric railway work and lighting for factories, mills and general work. Best regulation and economy guaranteed. Also builders of Steam Boilers. We solicit the furnishing of steam plants complete, including everything. Send for our CORLISS ENGINE PAMPHLET and list of references.



ICE MAKING
AND REFRIGERATING
MACHINERY

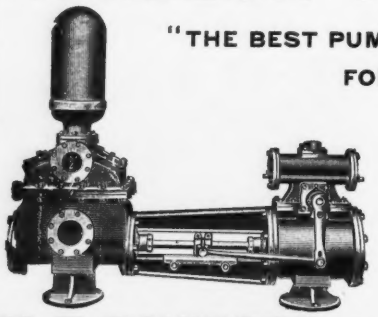
We furnish complete plants for ice-making and refrigeration for Breweries, Packing Houses, Cold Storage, etc. All refrigerating capacities from 2 to 300 tons; ice-making plants from 1 to 1000 tons per day. We publish a book describing Ice-Making and Refrigeration, which will be sent to intending purchasers.

NEW YORK OFFICE: Taylor Bldg., 39-41 Cortlandt Street

DAVIDSON PUMPS

"THE BEST PUMP BUILT"

FOR ALL SERVICES



Finest Mechanical Design and Construction

Material and Workmanship first class in every respect.

SEND FOR CATALOGUE

M. T. DAVIDSON 141 Broadway, New York

ELECTRIC, HYDRAULIC, STEAM BELT AND HAND POWER

ELEVATORS

FOR

PASSENGERS and FREIGHT

INSTALLED OR REPAIRED

Parts for all kinds of Elevators carried in stock.
Repairing done on shortest notice.

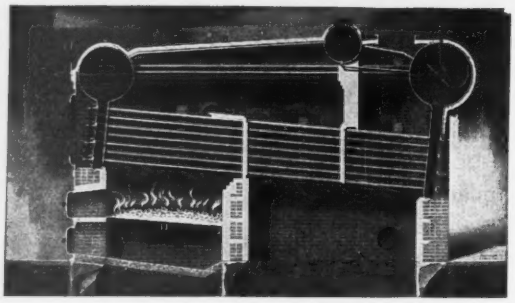
Keystone Elevator Inspection and Repair Co.

923 Locust Street, PHILADELPHIA.

ESTIMATES ON NEW WORK

BOTH PHONES

ATLAS



ENGINES AND BOILERS

CORLISS	WATER-TUBE
FOUR-VALVE	HIGH PRESSURE TUBULAR
SINGLE-VALVE	STANDARD PRESSURE TUBULAR
AUTOMATIC	INTERNAL FIRED
THROTTLING	LOCOMOTIVE TYPE

For Immediate Delivery

ONE 18 x 34 x 42 R. H. HEAVY-DUTY CORLISS
ONE 15 x 28 x 42 R. H. HEAVY-DUTY CORLISS

(These are new engines, never out of the shop.)

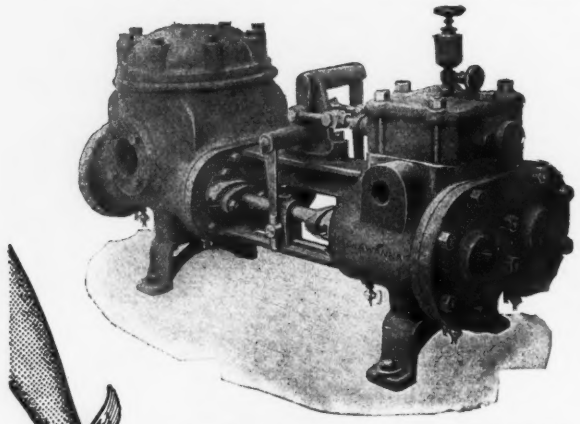
Atlas Engine Works.
Indianapolis.

For prompt attention address Dep't P.

Get Up-to-date

Another year is almost gone, yet some engineers are still unaware that there is a pump constructed with a view to lightening there labors. Don't let the new year find you not posted on the modern boiler feed pump.

Write to-day for our interesting booklet



LACKAWANNA PUMP WORKS

Walnut St. & Capouse Ave.

SCRANTON, PA.

ORDERS ALWAYS FOLLOW

EVERY TRIAL OF

KEYSTONE GREASE

Because it needs no further argument to convince an engineer that it is the longest lasting, most service giving, friction reducing lubricant on the market.

KEYSTONE GREASE

is the best of all lubricants, and we leave it to KEYSTONE GREASE to prove it.

Try it where you will, on any kind of bearings, any kind of machine; try indoor and outdoor where temperature is highest or lowest, or where it constantly changes from one extreme to the other, and we stake our word that KEYSTONE GREASE will give perfect results,—entire satisfaction.

A single pound will last longer and do better work than 3 to 4 gallons of high grade oil, or from 3 to 5 pounds of any other grease or lubricating compound—barring none.

FREE

A large can and a heavy brass grease cup to every engineer, who will send us his name and business address.

KEYSTONE LUBRICATING CO.

We are independent manufacturers. No connection with oil trusts.

20th and Allegheny Avenue,

PHILADELPHIA, PA.

In sending name, please state size of tap — also horse power and where it is intended to use grease so that we can send the proper cup

SOMETHING TO CROW ABOUT!

We have a Covering for Steam Pipes that's worth crowing about.

It's a combination of Asbestos and Magnesia and is the best of its kind on the market.

Try it yourself and be convinced.

CATALOG AND PRICES ON REQUEST

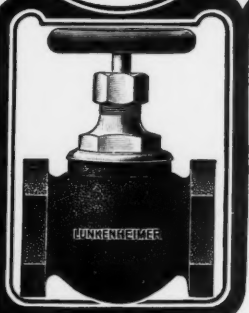
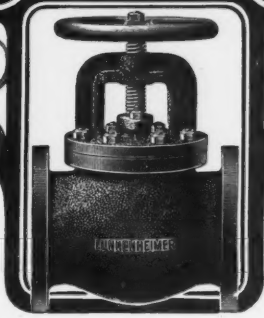
NORRISTOWN COVERING CO.
NORRISTOWN, PA.

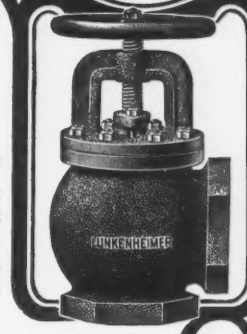
KEYSTONE PHONE—263 BELL PHONE—137-A

BRANCHES

BOSTON NEW YORK PHILADELPHIA BALTIMORE

LUNKENHEIMER VALVES



Iron Body, Brass Mounted, Globe, Angle, Cross, Check, Swing Check Valves

Are built on lines to please and possess the highest quality and best material obtainable. They are not made on the slip-shod, indifferent plan where quantity alone figures. Made in standard sizes. If you want first-class valves specify *Lunkenheimer* and order from your dealer. Write for catalog.

THE LUNKENHEIMER COMPANY, CINCINNATI, O., U. S. A.

Largest Manufacturers of Engineering Specialties in the World.

Branches: NEW YORK, 26 Cortlandt St. LONDON, 35 Great Dover St. PARIS, 24 Boulevard Voltaire.

Sales Agents for Philadelphia and Vicinity: FORD & KENDIG CO., Nos. 1428-1432 Callowhill Street.

Engineers and others interested are invited to call and inspect a full line of Lukenheimer Specialties.

NONPAREIL CORK

PIPE COVERING

SHEET CORK For Cold Storage Insulation

—ALSO—

ASBESTOS and Air Cell COVERING

John R. Livezey
1936 Sansom Street
PHILADELPHIA

AGENCIES
BALTIMORE
WASHINGTON
CHICAGO

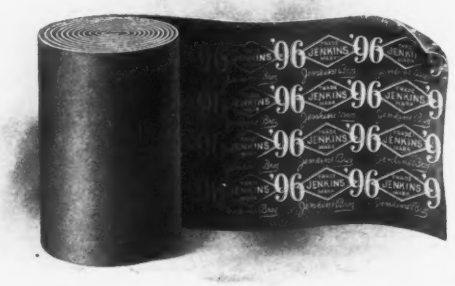
The Nonpareil Cork Works
80 Hudson Street NEW YORK

JENKINS '96 PACKING

Engineers know the annoyance—owners the expense—of a leaky steam joint. Use Jenkins '96 Packing—which is absolutely guaranteed; it will save both annoyance and expense.

You can place Jenkins '96 Packing in a joint when cold, screw up the bolts carefully, and leave the joint with perfect confidence that it will be tight. You do not have to follow it up.

But the best part about Jenkins '96 Packing is that it will last. With most joint packings the high heat soon disintegrates them, the packing commences to come out in little pieces, and steam blows through between the pieces. This is never the case with the Jenkins '96 Packing, for a joint once made will stay made. It will last for years, or as long as the metals which hold it.



Do not accept any Packing as "Jenkins '96" unless stamped with our Trade Mark as shown in cut.

Send for a copy of our booklet.—POINTS ON PACKING."

JENKINS BROS.

71 John Street, NEW YORK
133-137 N. Seventh Street, PHILADELPHIA
31-33 N. Canal Street, CHICAGO
35 High Street, BOSTON
62 Watling Street, Queen Victoria Street, LONDON, E. C., ENGLAND